FOREST FINANCE

HERMAN H. CHAPMAN

Collins, H. J.

FOREST FINANCE

BY

HERMAN HAUPT CHAPMAN, M. F.

Harriman Professor of Forest Management
Yale University

FIRST EDITION

NEW HAVEN, CONN.
PRESS OF THE TUTTLE, MOREHOUSE & TAYLOR COMPANY
1926

COPYRIGHT, 1926,
BY
HERMAN HAUPT CHAPMAN

THE TUTTLE, MOREHOUSE & TAYLOR COMPANY,
NEW HAVEN, CONN.

To

JOSEPH TRIMBLE ROTHROCK

Pioneer in Forestry

Died October 29, 1922, at age of 83 years.

INTRODUCTION

This text supercedes Forest Valuation published in 1914. The contents have been entirely rewritten and considerably enlarged. The same general method of treatment has been retained, namely, to present in the introductory chapters a short discussion of elementary economic principles as they apply to forestry. In determining either value of property or the rate which can be earned on forest investments it is necessary to understand such elements as the forces which determine prices, the law of marginal values and the true character of interest. The first eight chapters are devoted to these discussions, with especial reference to the economic difference between a going concern and one in the formative period as this question affects the treatment of interest. The subject of the rate of compound interest in all its bearings on the industry of forest production has been given special consideration.

Appraisals of property are dealt with under the three heads of cost value, capital value and market value. The methods of determining the rate earned by forest investments have been brought up to date.

In the two chapters on appraisal of damages the principles of such appraisals have, it is believed, been clarified and rendered more serviceable for application in damage cases.

The subject of stumpage value appraisals has been expanded to three chapters, in the last two of which considerable material has been borrowed directly from the Circular of Instructions for Appraising Stumpage on National Forests, U. S. Forest Service, 1922.

The chapter on taxation of forest property represents the author's conclusions as to the ultimate form which this policy should take, and sets forth the economic problem involved and the methods of determining the comparative burdens of taxes borne by forest enterprises during their development and as going concerns.

The last two chapters are devoted to forest insurance in an effort to make generally available the existing information on

this subject. With the exception of a few paragraphs in Chapter XIX on hazards, the material for these two chapters was furnished by Prof. Paul A. Herbert, of the Forestry Department, Michigan Agricultural College, to whom full credit is due. The preliminary chapters on economics have been reviewed and criticized by Mr. Walter J. Couper of the Department of Economics of Yale University and are in harmony with the principles taught in that department.

Acknowledgment is made for helpful and constructive criticisms of Chapters IX to XII by Professor H. C. Belyea of the New York State College of Forestry at Syracuse; Chapters XIII and XIV by Mr. C. F. Korstian of the Appalachian Forest Experiment Station, U. S. Forest Service; Chapters XV to XVII by Mr. E. E. Carter of the U. S. Forest Service, Washington, D. C.; Chapter XVIII by Professor Fred R. Fairchild of Yale University, and Chapters XIX and XX by Professor Paul A. Herbert. In addition Prof. C. H. Guise of the Department of Forestry at Cornell University has reviewed Chapters IV and VII. Mr. W. G. Howard of the Conservation Commission of New York State sent valuable material on damages, and Mr. D. T. Mason, Portland, Oregon, Mr. John E. Jenks, publisher of the Army and Navy Register of Washington, D. C., and Mr. E. H. Wilkins, Deputy Controller of the State of Connecticut, have reviewed certain portions of the text.

Private forestry in America is struggling under a tremendous financial handicap of combined misinformation, tax hazard, fire hazard and depletion or destruction of forest capital. There is an increasing tendency to regard public ownership and public expenditures as the only way out. This volume has for its main purpose the setting forth fairly and completely of the possibilities of forestry as a private business enterprise, in the hope that ultimately the tremendous area of forest land which must always remain in private hands may be made an asset and not an increasing liability to owner and public alike.

HERMAN H. CHAPMAN.

New Haven, Conn.,
April 15, 1926.

CONTENTS

CHAPTER I

THE ECONOMIC BASIS FOR FORESTRY

Article		Page
1.	Basis of Value for Forest Property	1
2.	Historical Development of Forest Property	3
3.	Importance of Natural Resources in Modern Industry	4
4.	Forestry a Modern Need	5
5.	Wood as a Raw Material	6
6.	Profit in Relation to Public and to Private Forestry	7
7.	Possibilities of Forestry by Public and by Private Initiative	8
8.	Importance of Attaining a Gradual Transition to Forestry	10
9.	Place of Forestry as an Organized Public Enterprise	11
10.	Definition and Scope of Forest Finance	12
11.	Forest Valuation and Forest Statics	14
12.	Relation of Forest Finance to Other Branches of Forestry	14

CHAPTER II

THE BUSINESS ENTERPRISE

13.	Character of a Business Enterprise	17
14.	Fixed Investments	17
15.	Outlay and Income	17
16.	Working Capital	19
17.	The Flow of Capital through the Business	20
18.	The Returns to Capital	21
19.	The Guarantee of Interest on Borrowed Capital	21
20.	Relation of Proprietor's Profits and Borrowed Capital	22
21.	Entrepreneur's Gain versus Profits	23
22.	Losses and Profits	23
23.	Cost Accounts	24
24.	The True Nature of Interest	25

CHAPTER III

ECONOMIC PRINCIPLES UNDERLYING FOREST FINANCE

25.	Relative versus Positive Value	27
26.	Market Value	27
27.	Use Value versus Cost Value	28
28.	Monopoly Values	29
29.	Relation of Use, Cost and Market Values	31
30.	The Law of Rent or Marginal Values	32
31.	The Forces which Determine Value	34

CHAPTER IV

THE MEASUREMENT OF TIME VALUES IN FORESTRY

Article		Page
32.	The Influence of Time on Values	36
33.	Dependence of Value on Utilized Energy	36
34.	Simple Interest and Discount	38
35.	Compound Interest and Discount	39
36.	The Present Moment the Basis of Valuation	41
37.	Determination of the Rate Earned	42
38.	The Time Element in Investments in Forest Production	43
39.	Importance of Annual Income and Sustained Yield	44
40.	Rates of Current or Annual Income	44

CHAPTER V

THE DETERMINATION OF PROFITS IN LAND ENTERPRISES

41.	The Basis for Values in Land	46
42.	The Two Sources of Profits	47
43.	The Investment Basis for Computing Profits	47
44.	Changes in Values of Capital Invested in Land	48
45.	Effect of Monetary Changes	49
46.	Factors Determining the Rate of Profit	50
47.	Average and Deferred Profits	51
48.	Income Earned versus Income Withdrawn	51
49.	The Comparison of Profits on Basis of Annual Rate Earned	52
50.	Ratio versus Rate of Profit	55
51.	Direct Appraisal of Rate of Annual Profit	56
52.	Profit in Terms of Capital Values	56

CHAPTER VI

RENTALS

53.	The Definition of Rentals	60
54.	The Summation of Rentals	60
55.	The Past Versus the Future in Summation of Rentals	62
56.	General Formulae for Obtaining Sum of Rentals	64
57.	Specific Formulae for Sum of Rentals	66
58.	Conversion of Intermittent into Annual Rentals	70

CHAPTER VII

FOREST RENT VERSUS SOIL RENT

59.	The Effect of Rate Earned on Value	71
60.	The Going Concern	71
61.	The Formative Period	72

ARTICLE PAGE
62. Continuity of Income ... 72
63. Creating a Going Concern in Forestry ... 73
64. The Business Unit the Basis of Operating Income ... 73
65. Net Operating Income versus Liquidation of Capital Assets ... 74
66. Annual Operating Income versus Accumulating "Costs" ... 75
67. Forest Rent ... 76
68. Soil Rent ... 77

CHAPTER VIII

THE RATE OF INTEREST AND THE ENTREPRENEUR'S GAIN

69. Interest Rate as a Commodity Price for Capital ... 80
70. Interest Rate as a Regulator of Enterprise ... 81
71. Factors Affecting the Interest Rate ... 82
72. Factors Determining the Entrepreneur's Gain ... 82
73. Entrepeneur's Gain in Forestry ... 84
74. Interest Rates on Loans in Forest Enterprises ... 85
75. Rates Earned as a Basis of Investment in Forest Enterprises ... 85
76. The Law of Diminishing Returns versus Compound Interest ... 87
77. Compound Interest on Money Capital versus the Rate of Interest 89
78. The Ratio of Profit versus the Rate of Compound Interest ... 89
79. Entrepreneur's Gain Expressed as a Margin of Rate Earned over the Rate of Interest ... 90
80. The Basic Rate of Interest in Forestry ... 92

CHAPTER IX

COST VALUE OF FOREST PROPERTY

81. Characteristics of Cost Value in Forestry ... 95
82. Capital Investments in Timberlands ... 96
83. Operating Costs—Establishment of Crop ... 98
84. Operating Costs—Annual Expenses ... 101
85. Operating Income ... 103
86. Cost Value for a Forest which is a Going Concern ... 104
87. Cost Value for a Forest with Deferred Income ... 105
88. Cost Value of Speculative Timber Holdings and Single Stands ... 107
89. Cost Value of Producing a Timber Crop ... 108

CHAPTER X

CAPITAL VALUES OF FOREST PROPERTY

90. Considerations affecting Capital Value ... 111
91. Capital Value of a Forest Producing Annual Income ... 113
92. Capital Value of a Forest whose Income is not Continuous ... 116

ARTICLE PAGE
93. Capital Value of Single Stands of Timber whose Income is Deferred 118
94. Capital Value of an Even-aged Stand of Timber..... 122
95. Capital Value of Bare Soil..... 126

CHAPTER XI

MARKET VALUES OF FOREST PROPERTY

96. Purchase Areas..... 130
97. The Basis of Market Values..... 131
98. Appraisal of Market Values..... 132
99. The Market Value of Land..... 134
100. The Market Value of Merchantable Timber..... 135
101. The Market Value of Young Timber..... 137
102. The Market Value of Improvements..... 138
103. Other Market Values..... 138
104. The Market Value of Forest Property..... 139

CHAPTER XII

THE RATE EARNED BY FOREST INVESTMENTS

105. The Rate Earned Annually..... 140
106. The Rate Earned over Periods of Deferred Returns—The Indicating Per Cent..... 140
107. The Rate Earned by a Timber Crop—The Mean Annual Forest Per Cent..... 143
108. Method of Trial and Error..... 144
109. Method of Charting the Per Cent Curve..... 148
110. The Rate Earned as a Basis of Appraisals of Young Timber.... 150
111. Entrepreneur's Gain in Forest Investments..... 155

CHAPTER XIII

PRINCIPLES UNDERLYING THE APPRAISAL OF DAMAGES

112. The Universal Principle of Damages..... 160
113. Method of Settlement of Damages..... 161
114. Possession and Use of the Basis of Damages..... 161
115. Equitable Standards of Valuing Damages..... 161
116. Appraisals Based on Capital Value..... 163
117. Appraisals Based on Cost Value..... 164
118. Appraisals Based on Market Value..... 165
119. The Physical Basis of Appraisals..... 167
120. Appraisal of Soil Value..... 167
121. Appraisal of Merchantable Timber..... 170
122. Appraisal of Immature Timber..... 171
123. Appraisal of the Damages or Loss in Value..... 172

CHAPTER XIV

THE APPRAISAL OF DAMAGES TO FOREST PROPERTY

Article		Page
124.	Damage to Merchantable Timber	175
125.	Damage to Timber which Cannot be Logged Immediately	176
126.	Total Destruction of Immature Timber	180
127.	Separation of Timber and Soil	181
128.	Additional Damage to Land	185
129.	Additional Costs of Reëstablishing the New Crop	186
130.	Additional Costs of Protection	187
131.	Damage to Soil, Appraised by Estimating Damage to Succeeding Crop	188
132.	Partial Damage to Immature Timber	189
133.	Damage to Many-aged Stands	190
134.	Damage to Watersheds	194
135.	Damage to Aesthetic and Recreational Values	195
136.	Punitive Damages	196

CHAPTER XV

THE BASIS OF STUMPAGE VALUES

137.	Definition of Stumpage Value	197
138.	Physical Basis for Stumpage Values	198
139.	Economic Basis of Stumpage Values	200
140.	Changes in Stumpage Values	203
141.	The Basis of Appraisal	206
142.	Readjustments of Stumpage Values in Long Term Sales	207
143.	Cost Versus Value of Stumpage	209

CHAPTER XVI

INCOME, INVESTMENTS AND COSTS IN STUMPAGE APPRAISALS

144.	Importance of Use of Average Figures in Appraisals	213
145.	Gross Income	214
146.	Elements of Cost	216
147.	Analysis of a Proposed Operation	218
148.	Fixed Investments	222
149.	Depreciation of Fixed Investments	225
150.	Calculation of Annual Depreciation and Average Profit-bearing Investment	230
151.	Operating Costs	233
152.	Working Capital	238
153.	Overrun	241

CHAPTER XVII

MARGIN FOR PROFIT AND RISK, AND STUMPAGE VALUES

Article		Page
154.	Margin for Profit and Risk	243
155.	Risks	244
156.	Basis for Computing the Margin for Profit and Risk	246
157.	Stumpage Value by Overturn Methods	247
158.	Modifications of the Overturn Method	249
159.	Investment Method	250
160.	Application of Method to Mixed Stands	253
161.	Stumpage Values in Mixed Stands	255
162.	Special Products and Small Sales	257
163.	Form for Summarizing Essential Data in Stumpage Appraisals	258
164.	Appraisals for Purchase of Stumpage	260

CHAPTER XVIII

TAXATION OF FOREST PROPERTY

165.	Forests as Taxable Wealth	262
166.	Income Taxes versus Property Taxes	262
167.	The Problem of Equalizing the Tax Burden	263
168.	Present Tax Conditions on Timber Lands	265
169.	The Objectives of Reform in Forest Taxation	265
170.	General Versus Local Tax Reform	267
171.	Taxation of Mature Timber	268
172.	Property Tax versus Tax at Time of Cutting	269
173.	Taxation of Forest Land Bearing Immature Timber under the Property Tax	271
174.	Taxation of Forest Land, Public Considerations	273
175.	Tax Income Produced by Forests under Different Systems of Taxation	274
176.	Comparison of Property Tax and Tax on Income	278
177.	Reasons for Failure of Property Tax as Inducement to Practice Forest Production	279
178.	Possible Concessions or Inducements to Private Owners	280
179.	General Concessions. Exemptions of Immature Timber and Substitution of a Yield Tax	281
180.	Special Concessions. Contract Relations	282
181.	Computation of Property Taxes	283

CHAPTER XIX

HAZARDS IN FOREST INVESTMENTS

182.	Hazards—Definition and Classification	286
183.	The Reduction or Control of Hazards	287
184.	Fire Hazards	289
185.	Other Hazards	292

CHAPTER XX

FOREST FIRE INSURANCE

Article		Page
186.	The Characteristics of Insurance	295
187.	Forest Insurance Organization	295
188.	Insurance Rates and Rating	298
189.	Evaluation of Insurance Losses	300
190.	Adjustment of Loss	303
191.	Insurance Costs	305

APPENDIX A

Problems in Forest Finance 308

APPENDIX B

Tables of Compound Interest 323

Index 333

FOREST FINANCE

CHAPTER I

THE ECONOMIC BASIS FOR FORESTRY

1. **Basis of Value for Forest Property.** — *Forest property* consists of land bearing forest trees as its principal crop. Bare land may be potential forest property if it is adapted to the raising of forest trees. Land bearing forest trees may in turn be potential agricultural land if it is adapted to farm crops.

A tract should be classed as forest property as soon as the young trees are established, and ceases to be so when this cover is removed or destroyed without replacement, though it may remain *potential forest property* and may constitute part of a forest estate.

Other products of forest land. — In addition to the products of tree growth, forest land may produce large quantities of brush suitable for food for grazing animals, and termed browse, and of various annuals or weeds and grass. The amount of such forage is usually in inverse ratio to the density and completeness of the forest cover. Game is directly dependent on the forest for food and shelter, and with fish from waters contained within the forest boundaries constitute important by-products of forest land.

A forest estate. — The realization of an income from forest property requires the development of roads or other means of transportation for logs and wood products, the installation of telephones, protective improvements such as fire lines, fire lookouts, and fences, and the building of houses and other structures for the administrative force and the equipment. A tract so improved and placed under management becomes a forest estate, organized so as to realize the values latent in the property. Small forest tracts may get the benefit of such improvements through being attached to farms or other forms of land estates, or in part through public roads and fire towers, but the larger the estate, the more complete will be the internal improvements required in order to develop and realize its possibilities of income.

Sources of value. — The basis of value for forest property must be sought in the various *uses which it serves,* and the benefits which it confers on the users. The larger benefits which mankind derives from forests lie in three distinct zones, each of which is of outstanding importance, namely, *recreation, protection,* and *production.*

In appraising the value of a forest estate, the sum of values from these three sources must be obtained, to which must be added that of the forage, fish and game, and any incidental mineral, agricultural or other resources contained within the area. Should these latter values outweigh the sum of the forest values, the estate as a whole would probably be managed for other purposes, and forestry be incidental.

Recreational values of forests tend on some areas to exceed all other values, but such instances are usually confined to small tracts possessed of unusual attractions combining scenic features, the presence of bodies of water, and mature or old trees. This leads to the segregation and exclusive use of such tracts for this purpose.

Protective values represent the influence of the forest in the regulation of stream flow and control of floods, the safeguarding of the purity of drinking water, the interposition of barriers against avalanches, the checking of soil erosion and of drifting sands, and the moderation of the force of winds. The beneficial protective influences of forests are not usually confined to the sites on which they stand, but may be distributed over wider areas and to points far removed. The value of such influences is often very great, amounting even to the difference between preservation and destruction of much adjoining property. Such controlling areas should if possible be publicly owned.

Commercial values. — As distinguished from the above uses, forest property has commercial value as a source of raw materials for industrial and domestic consumption. The product is principally wood, but forest trees also yield many bi-products such as naval stores, sugar, bark (cork), mast (seeds eaten by grazing animals, as hogs), nuts, and litter. These raw materials form the basis of vast business enterprises dependent on a continuing supply for their existence. The harvesting, transporting and delivering of these materials at point of manufacture constitutes

the *logging industry,* on which rests in turn *lumber manufacture and wood-using industries.*

The securing and guaranteeing of a perpetual supply of wood material, by keeping forest land productive and growing timber as a crop, constitutes a business in itself entirely apart from lumbering and its dependent industries. This enterprise is termed forestry, and resembles agriculture in that the purpose of both is to guide the processes of nature in producing as crops from the soil the organic materials which are indispensable to human existence and civilization. Forest land and growing trees constitute the capital required in this business and the net value "on the stump" of the tree content is the basis of the commercial value of forest property.

2. Historical Development of Forest Property. — *The process of forest destruction.* — The development of the use of forests by man has taken much the same course in all ages and all regions. The savage leaves the forest practically intact. With the rise of civilization, the process of clearing land for agriculture sets in, and results in the destruction of a large percentage of the most valuable and productive portions of the virgin forest, with very incomplete utilization of the products. There follows the growth of urban populations and of arts and manufactures, accompanied by widespread exploitation of the forest remaining on non-agricultural soils, usually with inadequate provision for their renewal and perpetuation. Various destructive elements, which in the natural forests were held in check, become virulent as the result of this disturbance of the balance of nature. Forest fires increase in frequency and destructiveness. Grazing animals consume the reproduction. Insect attacks become serious and widespread. The soil deteriorates and disastrous erosion occurs wherever the texture of the soil and the topography permit it. By these cumulative processes, for which man is directly responsible, the original forests are destroyed more or less completely. In many countries or districts where unfavorable climatic conditions are encountered, this destruction becomes permanent, as in the well-known case of the cedars of Lebanon.

The transition from savagery. — The significance of the problem thus presented as it confronts modern society may be better grasped by drawing a parallel between the threatened timber famine and the

conditions which must have marked the initial transition of man from a race of savage hunters to civilization based on production of food crops. As long as the natural products of the earth, such as game, fish and wild fruits, constituted the main sources of food, the primitive population was limited in numbers by this food supply, which they endeavored to conserve. This stage was succeeded by the pastoral and the agricultural epochs in which the food supply was rendered stable and abundant by controlling and utilizing natural forces through grazing of domestic herds and the tilling of the soil.

This transition must have been slow, for it required the development of three fundamental requisites of progress, namely, foresight to plan for the future, abstinence resulting in the accumulation of food capital to tide over the period of crop production and coöperation or organization for mutual protection to prevent the spoliation of the individual or tribe by those who still preferred the savage state. The continuance, in part, of the natural food supply must have aided in attaining this capitalistic state, just as in pioneer regions in America, game and fish formed an indispensable aid to the early settlers in the initial stages of their struggle to clear the land for farming.

To primitive man, the development of his foresight and expansion of his capital to cover the crop season or year marked a tremendous advance in contrast to the day, week or month as limited by the accumulation and preservation of the spoils of the chase. Undoubtedly the higher qualities of mind and character thus called into play laid the foundations for the further progress of civilization.

3. **Importance of Natural Resources in Modern Industry.** — *The foundations of industrialism.* — In modern times the development of industrialism with its extensive use of raw materials obtained from the stored up natural resources of mine and forest is concentrating an increasing percentage of the population in large cities. Of these a very large proportion are engaged directly in manufacturing and still others in trades or professions which are indirectly dependent on these industries. The possibility that these supplies of raw materials will be exhausted by unusual and increasing demands is a matter of vital concern not merely to those employed in their manufacture but to the entire population as consumers of the products and beneficiaries of the industrial system.

Sources of raw materials.—These materials, with the exception of the yield of the waters, must come from three main sources, farms, forests, and mines. *Agricultural products* are mainly food crops, or textiles, produced on soils of the better grades whose total area is limited and will all be required to feed an increasing population. Such soils by proper treatment can be maintained perpetually, but by primitive methods are often rapidly impoverished. The total stock of *minerals* cannot be increased and tends toward exhaustion by use, requiring conservation to prevent undue waste. In most instances, a supply is in sight sufficient to last for several centuries. Oil is an exception and the visible and probable supply may be exhausted in twenty to thirty years.

The *forest resources* under the enormous drain of modern industry are threatened with serious depletion in a comparatively short time, thus indicating their high utility, and the lack of foresight which has marked their exploitation. The forests, unlike the mines, are renewable by the same natural forces which have produced them in the past. These forces, however, can no longer be depended upon unaided to replace the forests in the face of the intensive utilization and profound disturbance of the balance of nature caused by these changed conditions.

4. Forestry a Modern Need. — Men in this industrial epoch are again faced by the necessity of controlling and guiding these productive processes in order to utilize the soil for the replacement of needed organic materials. Forest crops must now be added to food crops. Agriculture at its best can utilize profitably but a small percentage of the total land surface. This varies from 85 per cent in states like Iowa, down to negligible proportions in mountain or desert regions. Forests can be grown on all non-agricultural soils where there is a sufficient minimum of rainfall to support tree growth and the climate is not too cold. The total area of soils in the United States which will find its most profitable economic use in forest production is 470,000,000 acres which exceeds the area of land devoted to crop production by 105,000,000 acres.* Its permanent devastation is possible by neglect of proper methods of forest protection and management, while if made productive it will supply all our future needs for wood.

The *great obstacle* to be overcome in forest production is the *time* required to bring forest crops to maturity. But this achieve-

* Timber, Mine or Crop. Yearbook of Department of Agriculture. 1923.

ment should be no more difficult for a progressive modern society than it was for primitive savages to surmount the same sort of time barrier in the transition to crop production. The success of forestry will depend upon the ability of a race to exercise the qualities of foresight and provision for the future which are now as always an indispensable requisite of progress.

5. Wood as a Raw Material. — *The advantages of wood as a raw material* lie in its general utility. It furnishes either fuel energy or materials for manufacture and use. It is readily fabricated even by amateurs into articles of any shape for almost any purpose. Being of vegetable origin, its substance by distillation yields various products which are in increasing demand, while its fiber makes it suitable for paper.

Substitutes for energy are found in coal and oil. Substitutes for structural materials are obtained from minerals. In theory, all needs for wood might be filled by substitutes. This substitution is beneficial when it proves to be cheaper and more serviceable than wood. But wood itself finds its chief value because *it is a satisfactory substitute* for other mineral or fuel products and keeps down their cost. With a scarcity of wood supply, this great advantage is lost. For many purposes, such as railroad ties and paper manufacture, no satisfactory substitute for wood has been found.

Economic consequences of forest destruction. — The increase of per capita consumption of wood is limited only by the diminution of the supply and the consequent enforced use of substitutes. With the exhaustion of the wood crop in a region of natural forest soils, industries languish, whole districts revert to a wilderness, tax revenues dwindle, population and agriculture diminish, public improvements are abandoned, and civilization reverts to a condition less hopeful and less advanced than marked the era of initial development of the forest resource. In the larger wood-consuming districts the economic effects of this depletion are as yet postponed by long distance transportation of wood from remaining virgin stores. The full consequences will appear gradually, and will be tempered by the use of the various substitutes. But no amount of economic readjustment will serve to altogether avoid the evil effects of the elimination of so universal and important a raw material as wood, either as a basis of industry, or as a crop or yield on otherwise barren land.

A nation or race which deliberately condemns more than half of its total land resources to perpetual waste on the specious plea that it can more easily replace the potential yield of this land by drawing upon its remaining mineral resources, than to exercise the necessary qualities of foresight, abstinence and coöperation, is endangering its existence as much by its loss of these mental qualities as by its neglect of its physical foundations.

The three alternatives. — The continuance of private industry in the form of logging and lumbering as well as all kinds of manufacturing whose raw material is wood is limited by their ability to obtain this wood in the future. Three courses are open to them:

first, to seek merely to control or secure additional raw materials from the remaining areas of virgin forests, or from the accidental occurrence of second growth;

second, to endeavor to conserve and as far as possible produce new supplies by ownership and proper management of forest lands;

third, to depend upon purchasing from other owners the output of definite areas of forest which are under organized management for a sustained yield.

The tendency of the first of these courses exclusively pursued *is intensely destructive, without any mitigating or corrective features.* As wood becomes more scarce and valuable and is more closely utilized, destruction becomes more thorough and complete, and recovery of the forest by natural processes more improbable. It is therefore to the second or third alternative which the great wood-using industries must look for their survival.

6. Profit in Relation to Public and to Private Forestry. — *Conservation of energy.* — The production of timber is a business enterprise, regardless of whether it is publicly or privately conducted, but the principles which apply to the management of public forests and of private forests differ in important respects.

The underlying law of conservation of energy applies equally to public and private forestry. This is, that any outlay should produce the greatest possible income or benefit, and that the direction of such efforts should always be toward those forms of enterprise which promise the most profitable or beneficial returns.

Private versus public ownership. — Private enterprise must rely solely on making profits in excess of costs, else capital is exhausted

and the enterprise eliminated. On the other hand, a public enterprise may and usually should be run, not merely for profit, but for maximum public service. The public are in effect both consumers and stockholders. Their dividends are received not solely in augmented public revenues and reduction of taxes but in more efficient and cheaper service. Public investments also command lower rates of interest than private loans. Because of these conditions, the field of private forestry is more restricted than that of public forestry and the tendency of private owners is to reduce the forest capital, shorten the rotation or age of maturity and improve only the more profitable chances.

In public ownership, general considerations of public welfare in which the recreational use of land may play a part will usually justify the policy of acquiring or holding as public forests lands which are comparatively unproductive.

Common principles. — Public funds are required for both purchase and management, and public interests require the same care in appraisals of purchase values and expenditures as do private ventures with the difference that the public can afford to wait longer for the crop, hence can accept a lower rate of interest returns than private owners and hence can operate these less profitable lands (Chapter VIII).

In the choice of species, methods of treatment, products to be grown, size and age of crops to be harvested, extent of intermediate operations such as thinnings, and intensiveness of protection expenditures, there is no difference discernible between sound public and private forest policy except the same constant distinction that the public can exercise greater patience or abstinence, hence can plan the management of public forests for the production of greater quantities of more valuable products requiring more time for growth, and yielding a higher average annual income than will ordinarily be possible for the private forest owner.

7. Possibilities of Forestry by Public and by Private Initiative. — *Deterrents of private forestry.* — Forestry as a productive enterprise has been possible for public owners since the days when exploitation began on a large commercial scale, if not even sooner. The policy of retention of public forest lands was possible from the beginning of the colonial period, and has been consistently followed in Canada and rather tardily adopted by the Federal Government and by certain States.

Where forest property has passed to private ownership, the economic possibility of undertaking forest production as a commercial or profit-earning venture has been seriously delayed, handicapped and obscured by powerful factors operating against the success of such ventures and tending to discourage practical owners from attempting them. These are, in order, first, the competition on the market of the immense store of *virgin timber,* whose production had cost the owners nothing, and which made profit in the sale of artificially grown timber impossible as long as this condition continued; second, the almost certain destruction of the residual investment in young timber or seedlings by *forest fires,* against which the individual owner would have been helpless, in spite of excessive expense for protection; third, the vicious uncertainties of a system of *taxation* which was wholly at variance with the character of the income of artificially grown forest crops. Still another powerful deterrent was *habit.* The adoption of forestry by private operators and owners required the effort to familiarize themselves with a new business venture conducted on radically different lines from that along which they were operating. Existing conditions apparently held no warrant for the effort to acquire new technical knowledge, readjust management on new financial lines, or conform to new economic viewpoints. Future probabilities if visualized clearly would have offered abundant justification for such reorganization in numerous instances. Obviously, the marketing of crops requiring 40 years or more to produce would not meet with the competition of virgin timber if, long before these new crops were ready to harvest, the supply of old growth timber were exhausted.

Public coöperation a necessity. — Until organized society as a whole translated such foresight into practical measures of fire protection, tax reform and example or practice which demonstrated the success of technical processes of production, private owners did not dare to attempt it single-handed. These conditions, due to the efforts of pioneers of forestry such as Fernow, Pinchot, Rothrock and others are being rapidly secured.

Destructive tendencies of private ownership. — Meanwhile, so swift has been the pace of industrial progress that enormous and well-nigh irretrievable damage has been wrought, and the destructive tendencies have acquired such momentum that except in a few favored localities like the Pacific northwest, or by a small per-

centage of exceptionally well situated owners or operators, the pace set by their present scale of operation will carry these commercial enterprises on to the complete exhaustion of their store of forest capital, which will necessitate suspension of their operations. When this condition is recognized by an operator, he is only too apt to remain indifferent to the possibilities of forest production as a private enterprise in which he might otherwise be interested, and either openly resist public measures tending to require such practice or cherish the hope that before anything is done which will affect him, he will have cut all his timber. A clearer perception of the future, even if confined entirely to the prospects of private profit, in many instances would have and might yet reveal to such owners possibilities of preservation of values in growing timber or reproduction at small initial expense which with the lapse of time, even during the course of completing their operation, would transform a burden of waste and unproductive cutover land holdings into a property with merchantable value which could either be retained for future operation or readily sold.

8. Importance of Attaining a Gradual Transition to Forestry. — The transition from nomadic hunting to permanent agriculture was not sudden, but gradual. It will be fortunate indeed if in this modern world mankind through equal foresight is enabled to make the transition even in part from mere exploitation to forest production by a similar gradual adjustment. For if this foresight fails and the proper measures are not undertaken in time, the gap that will appear between demand and supply will be no less formidable than that which confronted the savage who had improvidently exterminated the game while neglecting to master the art of agriculture.

Certain nations have destroyed their forests through inability to develop the requisite progressive qualities necessary to curb the march of devastation. Other and more modern nations have awakened in time to public needs, and have in part effected this transformation before the destructive processes have run their full course. It remains to be seen to what extent a people can recover from the full effects of almost complete forest destruction with no attempt at transition and whether the social and economic forces will be equal to the strain.

If through the exercise of the requisite foresight and efficiency

a transition from improvident forest exploitation to the practice of forestry were brought about on a large scale, this would tend to secure, first, the continuance of revenue from forest properties and a marked amelioration of the enforced condition of abstinence or discontinuance of use of wood, through holding back and prolonging the supply before the latter gives out, thus preventing complete disruption of wood-using industries; second, the preservation of the full productive powers of forest soils and of the forest itself; third, the probable continuance of private industry in forest production.

9. Place of Forestry as an Organized Public Enterprise. — *Inadequacy of private forestry alone.* — In the successful establishment of forestry on a national scale, society faces a problem for which individual initiative alone has not so far given promise of adequate solution even with the utmost paternal aid contributed by public measures of fire protection and preference in taxation. This is due to the fact as noted that the period of crop production for the more valuable and necessary products may equal or exceed the span of human life. The production of the more valuable forest crops is then primarily for the benefit of the race and of future generations, and the responsibility therefor rests upon society to a markedly greater extent than in the case of food production. Foresight and abstinence are here required to a degree which transcends the ordinary limitations of the individual, who though he may be interested in providing for his children, will usually seek enterprises which promise results during his own lifetime. Modern business corporations, however, give promise of capacity to exercise such foresight in many instances, while for all classes of owners, the possibility of deriving an immediate and continuous revenue through the conservation and regulated cutting of existing remaining forests overcomes this time obstacle and makes such management possible even for small areas.

The need for public ownership. — This necessary strengthening of the common or public efforts in forestry must take the form, in part, of direct public ownership of forest land and the production by public management of the forest crops which require these long periods of time for their development. Meanwhile the protective machinery of government must be greatly strengthened to check the ravages of fire and of insects and diseases on all forest

property regardless of ownership. In all modern nations in which the practice of forestry has become established, public ownership and management of forest lands for the production of timber has played a large part.

Just as the better protective organization of society originally permitted the development of individual agricultural practice, so in this extension of man's foresight and control to include the creation of wood crops, the existence of publicly owned and managed forests should operate to encourage and establish to a much greater degree the successful private practice of forestry.

10. Definition and Scope of Forest Finance. — *Dynamic forces.* — Forestry is an empirical art and not a mathematical science. The two major premises upon which it rests, namely, human needs expressed in consumption of forest products, and the vital forces of tree life in their reaction to the composite factors of site including climate and soil, can be measured and predicted with only approximate accuracy. Yet upon these forecasts and appraisals the mathematics of Forest Finance must depend for its conclusions. This condition does not differ from that inherent in any other field of practical human effort dealing with dynamic forces.

Finance is the applied science of accounting in which the financial problems of a business are analyzed to determine the policies which should govern investments and expenditures, in order to secure the return of the capital invested and an adequate profit. *Forest Finance* deals with the business of forest production or forestry.

The principles of Finance cover two sets of problems, how to buy or sell property advantageously, by determining its value, and how to control and direct the expenditures of an enterprise in order to realize the largest profit.

All commercial enterprises, including forestry, are based on the principle of profit or adequate return on outlay. An *appraisal* of the amount and value of *probable gross income,* in spite of the difficulty of forecasting what this will be, is the mainspring which determines every expenditure of capital; the science of forest valuation rests on this premise, and efforts to appraise either value or profits must begin by estimating this prospective income.

Profit is the margin left after returning all operating costs and losses or depreciation of invested capital. The next step therefor

is to appraise the probable *future expense* of the enterprise and the amount of *capital required* for its successful consummation, in order to estimate the probability and amount of the margin for profit.

There exists in the field of investment a wide range of choice, both as to the particular form which an enterprise shall take, and the prices or value at which the property necessary to the conduct of this enterprise may be acquired. If too high a price is paid for property, the yield on this capital investment even from very productive enterprises may not be profitable, while if a relatively low cost is incurred in acquiring the property, satisfactory profits may be earned even from investments of low productivity.

Again, the owner may fail to realize that industry or even skill and efficiency in management do not alone determine whether an enterprise will prove profitable. The demand for the product, relative costs of competitors and other influences have fully as much to do with the outcome, and require a careful consideration of all contemplated outlay in an effort to visualize the probability of its return with interest. The *amount of net profit* indicated by such appraisals has little significance, until its *relative value* is found by determining the *rate* of return which it represents on the capital required to obtain it. This rate, by which alone two opportunities for investment can be compared, depends on three factors, net income, capital invested, and *time required to realize* the income. Obviously, if a profit of 50 per cent is earned in one year, the rate earned exceeds that for the same profit if ten years is required.

Most prospective investors have a well-formed idea as to the rate they require from their capital. In this case, they are primarily interested in the *price* at which they can buy. Others of the "entrepreneur" class are more interested in computing what *rate* a certain amount of capital will earn if put into a given project. The answer to each of these questions can be "appraised" by the following general formulae, for investments covering one year. For longer periods, substitute the word ratio for rate.

$$(1)\ \text{Value of property or capital} = \frac{\text{Appraised net income}}{\text{Required rate of interest}}$$

$$(2)\ \text{Rate of income earned} = \frac{\text{Appraised net income}}{\text{Capital invested}}$$

11. **Forest Valuation and Forest Statics.** — Profits are thus made, first, from net income earned by an enterprise, second, by buying or selling the property and the enterprise which it controls. The only true *economic profits* possible are those earned by industry, but, the *division of profits between individuals,* and the rate of profit earned, are profoundly affected by these property transfers. Thus Finance presents two fields, *Valuation,* which deals with the relations of purchaser and seller of property, or ownership, and attempts to arrive at fair values as the basis of transfers or sales; and *Statics** which, assuming a fixed ownership and an established purchase price, endeavors to determine the comparative rates of profit which may be earned by different forms of management and thus guide the owner in choosing the most profitable measures to adopt.

Forest Valuation appraises the present value of forest property, including standing mature timber, young growing crops and soil, either in the form of single stands, or of large tracts with a diversity of ages, kinds of timber and conditions of forest cover.

Forest Statics determines the rate of income yielded by investments in forest properties for different species of timber under different methods of treatment and different rotations, and indicates the most profitable forms of management in forestry.

12. **Relation of Forest Finance to Other Branches of Forestry.** — Forest Finance, as a science, is based on mathematics but draws its facts from both economics and from the physical laws of forest production. These relations are shown in Figure I.

Foundation subjects. — From *Forest Economics* is obtained the present prices and value of the forest crop, the future trend of demand and prices, and the indicated objectives towards which crop production should be guided. From *Silvics,* or the study of physical factors of site and the behavior of different species on these sites, we arrive at the choice of species and probable pro-

* Statics has a much broader meaning than this. Derived from the Greek στατική, the art of weighing, it is applied in sociology to that branch which treats of the conditions of the stability or equilibrium of the different parts of society. In Finance this equilibrium is secured through the interaction of rate of interest and rate of profit, hence Forest Statics has to do with the relative profits to be earned by different investments in forestry, as compared with other forms of enterprise.

ductiveness, which is then measured and predicted by *Forest Mensuration.*

In order to deal with these two sets of data in a manner conforming to sound principles, *Accounting* methods similar to those employed by any business but suited to the specific conditions and problems arising in forestry must be employed. On these foundations the science or subject of *Forest Finance* is based. It is essentially a mere statistical or mathematical science, dependent on other investigations, as shown, for its premises, and applying to these facts the mathematical calculations which will reveal their proper relations (§ 10).

Applied subjects. Policy. — The conclusions of Forest Finance

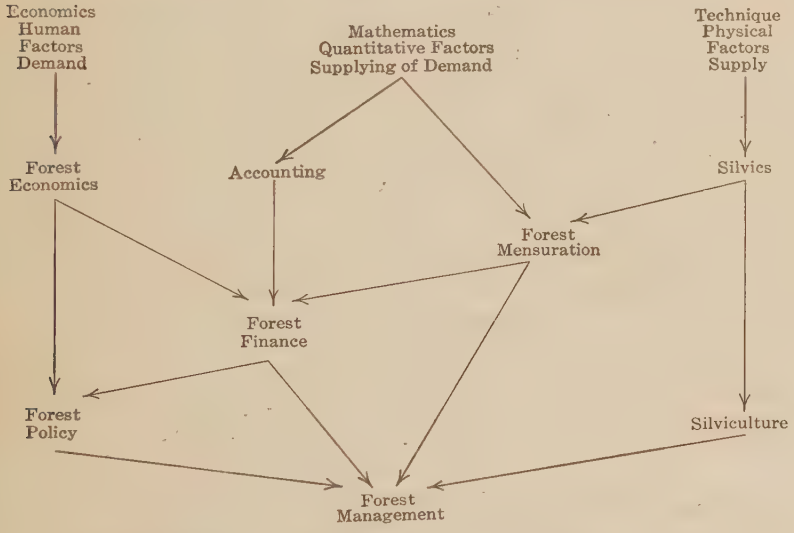


FIG. I.—Relation of Forest Finance to other branches of Forestry.

may influence public forest policy by indicating the financial position of the private owner and the moderation necessary in attempting to enforce public regulation, or by pointing out the respective fields of public and private land policy and ownership.

Silviculture. — Similar conclusions are of fundamental importance in determining the character and extent of operations permissible in the forest, both in harvesting and in improvement of the stand, by imposing the limitation that such operations must

show returns or profits, either now or eventually, which will justify the expenditure.

Management. — Forest Finance contributes not the least of several factors which directly determine the general plan of Forest Management as adopted for any area of forest land. As indicated by Figure I, the foundations of such a plan are, Policy, Silviculture, Mensuration and Finance.* Policy indicates the economic goal of management. Silviculture formulates the technical processes of production. Mensuration predicts the quantity and character of the raw materials which the enterprise should yield. Finance defines the practical measures which may be undertaken to reach this goal. Management, with the aid of Finance, erects upon these foundations an enterprise which seeks to attain success as gauged by efficiency, a margin of profit, and the highest possible return for the required expenditure.

* A more complete diagram will be found on Page 4 of Forest Mensuration, H. H. Chapman. John Wiley & Sons, N. Y. 1921.

CHAPTER II

THE BUSINESS ENTERPRISE

13. Character of a Business Enterprise. — *A business enterprise* is an undertaking whose aim is to produce *profit through service* in supplying some definite demand or need. In the conduct of public business the element of profit is subordinate to that of service. Enterprises whose field is the supplying of material wants are concerned with the transformation of the raw materials obtained from the earth into forms suitable for consumption, or in transporting or distributing these products. These processes require the employment of labor and the utilization of land, machinery, buildings and raw materials. They cannot be conducted without the investment of sufficient *capital* to carry the enterprise over the period of time required for the completion of the entire process. Many questions of forest finance relating to interest, profits, and accounting will be better understood if the true character of a business enterprise is first comprehended.

14. Fixed Investments. — In its relation to capital and to the proprietor or investor, a business enterprise is set up as a *separate entity,* receiving capital which is debited to the business and credited to the investor. Capital must next be exchanged for such forms of wealth as must constitute the fixed investments such as land, buildings, and machinery. Further exchanges take place in acquiring raw materials. So far, the value of the capital is not apparently altered or diminished, but merely changed in form. The liquid form, money, is used to advantageously acquire these assets whose value is considered the equivalent of the invested capital. Often, these forms of capital are directly transferred by the owner as his investment in the business.

15. Outlay and Income. — The true *business enterprise* can now be initiated, and must consist of employing the *forces* of labor, energy (fuel) and natural processes (growth) for definite periods of *time* in the production of raw materials from the earth or their transformation. The use of these forces means an outgo of energy, or expense. This outgo is in part dissipated or lost without compensating results, as for instance in the consumption of fuel where only part of the energy is utilized. But the directing

intelligence of the business must see that the largest possible per cent of the energy expended is not only harnessed, but produces useful results along the intended lines. This process results in transformation of materials and finally in supplying the consumer directly with what he needs. His payment of money in exchange for these services or goods completes the *circle of effort.*

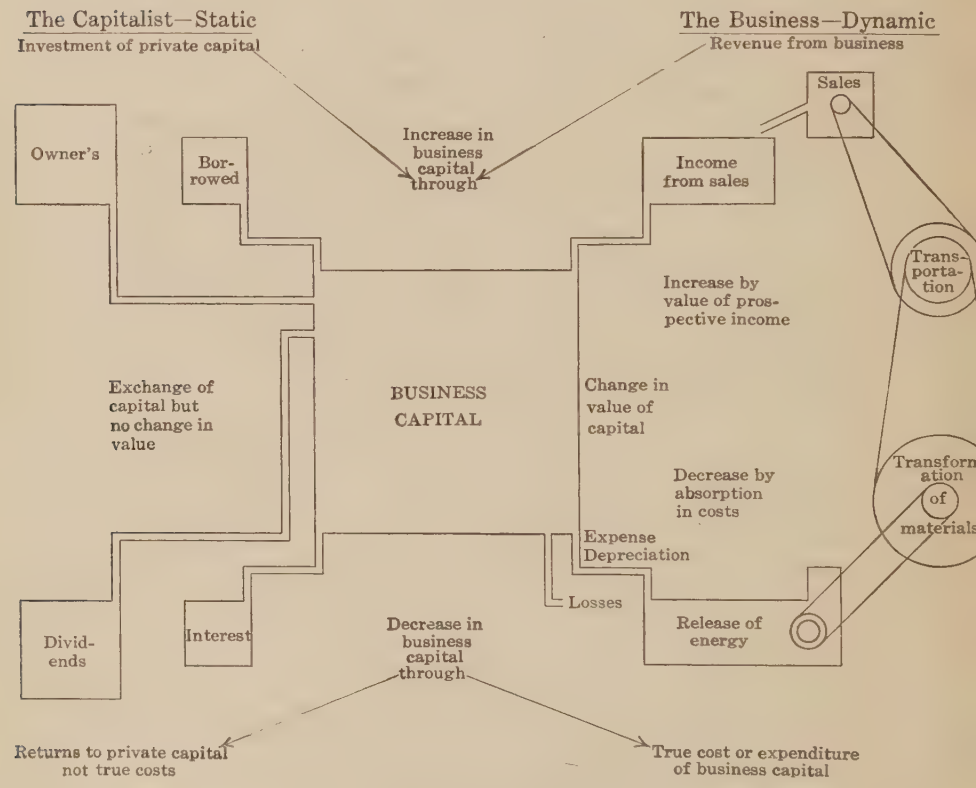


FIG. II.—The Business Enterprise.

The *income* thus finally secured from the public has the same effect in increasing the capital as would a similar amount invested by the owner or capitalist. This income supplants the need for new capital, and when sufficient in amount, permits of a return to capital in the form of interest and dividends.

These processes can best be illustrated by Fig. II which is merely symbolic. The central reservoir or tank represents the

capital available for business purposes, which in liquid form is money. A very large proportion, however, must be frozen into the other forms acquired by exchange, and cannot be reconverted into money without liquidation and loss or even termination of the business.

Out of this reservoir must flow the *expense* for wages, fuel, overhead, and materials consumed in the processes of manufacture. Some escapes on account of leaky equipment, or unavoidable direct loss. Depreciation represents the using up or wearing out of the "frozen" or more permanent forms of capital such as machinery or buildings, and is a legitimate and unavoidable expense incidental to production. In the course of the required time the energy thus generated effects the transformations which meet the consumer's desires, and the new stream of liquid capital starts its flow to replenish the reservoir.

If anything goes wrong in this process, or if the *losses or leakage, depreciation, and expense streams exceed* not merely the energy generated and transformations effected, but the *measure of the value of the final goods actually received in money by exchange,* the outgo will continue to exceed the intake until the liquid capital is drained and the tank runs dry. More capital must now be supplied by the proprietor, or else the frozen capital must be liquidated to recover as much as possible, and the enterprise abandoned. If the owner has no more capital, but the *credit* or prospects of the income stream materializing is good or the frozen capital is sufficient for security, he can borrow the additional capital needed, which has the same effect on the reservoir. Otherwise the process means bankruptcy and receivership, or a sale of the business.

16. Working Capital. — It is evident, first, that the intake of liquid capital must continue until the final income stream exceeds the outflow from all channels into the business enterprise; and that the longer the period and greater the rate of outflow during this period of incubation, the larger will be the total quantity of money or capital absorbed. These are the factors which fix the total required investment of capital. It is evident that no matter how much comes back as income, it does not tend to diminish the amount constantly contained or absorbed in the business processes from the time it leaves the reservoir until it is recovered from the purchaser. Many new undertakings change hands because of lack of understanding of the need for this additional capital *after* the

plant has been completed and the enterprise actually started. The amount thus required in the business process independent of fixed investments is termed *working capital.*

The amount of capital or content of the reservoir is a condition wholly distinct from the sources of supply. The "water" level *increases with intake,* whether this be from income or from additional investments of capital. In the same way the level *decreases* whether the outgo be on the side of *expense* into the business itself, or back to the *proprietor* and consequently out of the business. This ebb and flow of capital or liquid resources is thus affected similarly by similar amounts withdrawn from or poured into the receptacle, regardless of their origin or destination.

17. The Flow of Capital through the Business. — The sources of income and direction of outgo have a fundamental bearing on the continuance and results of the enterprise. Fig. II is divided to show the relation of the *capitalist* on the left to the *business* on the right. Capital from the left must first enter the reservoir and must then flow out, on the right, into the business. During its circulation after this withdrawal into the business process it will inevitably undergo a change in value. That which finally returns from the public, on the right side, as income, *should be considerably greater* in quantity than the flow of expense which produced it. If it is less, and there is no prospect of correcting the difference, the business should be discontinued as quickly as possible.

Unless a business is expanding, which requires an increase in the size of the reservoir and of the capital absorbed in business processes, this flow of income first renders unnecessary any additional investment by the capitalist, and then if it exceeds outgo, begins to fill up the tank. Unused capital earns no interest. This surplus must therefor either be withdrawn or used, unless held as a reserve against emergencies. Hence the choice is presented of *expansion* or of *declaring dividends.* A withdrawal of dividends to the left, thus voluntarily determined and controlled, is a *return to capital.* Both the intake and outgo of capital, on this left side, are mere *static exchanges* of capital between the business and the capitalist and do not either increase or decrease its actual quantity as wealth but only the quantity inside or outside of the business reservoir respectively, while on the contrary, the business outflow and intake, on the right, is a *dynamic* process which not only changes the

level of the reservoir but alters the quantity of capital itself, since it calls into play the forces both of destruction and increase.

18. The Returns to Capital. — We must now examine more carefully the processes taking place on the static or left side, representing the capitalist. In the first place, the business needs are served whatever may be the source of the capital, hence the *reservoir knows no difference between proprietor's and borrowed capital.* The total capital or the *adequacy of the supply* is all that matters. But evidently the total capital needed as determined by the amount absorbed or drained off on the right and corresponding intake from above will vary with the nature and volume of the expense and whether the replacement from income is steady or intermittent. If either the income or the expense is *irregular or periodic* it gives rise to an *intermittent or fluctuating demand* for working capital, which is usually rhythmic or seasonal, while by contrast the conditions governing investments tend to establish a fixed sum as the proprietor's capital represented for instance by capital stock. The difference periodically required can be secured by short term *borrowing*. A portion of the fixed capital can also be secured by borrowing on mortgage security or by issuing bonds.

When it comes to securing and withdrawing the returns expected by or due to capital, the first condition evident is that *capital gets no legitimate return* until income is received by the business in volume sufficient to exceed the total expense or drain, on the right, into the business. This *risk to capital* is ever present and accounts for the cautiousness of capitalists in undertaking new ventures. On the other hand, capital is entitled to *all* of the surplus in excess of this drain, of which wages constitute the chief item, and from this source arises profits, which encourages capital to undertake the risk not merely of loss of income but of loss of the capital itself which will surely be dissipated in an unprofitable business if continued too long.

19. The Guarantee of Interest on Borrowed Capital. — On the *borrowed capital,* for one form of which bonds are sold, *the interest is guaranteed.* This fact does not alter the dynamic requirements of the business itself in any way, that is, of the business enterprise, or right side, which requires, expends, and must receive a definite quantity of capital regardless of its origin. But it does seriously affect the relations of the left, static, or exchange side, that which concerns the owner or capitalist. Bor-

rowed capital is usually secured by notes, mortgages or other evidence of a *claim on ownership* which guarantees the safety of the capital. In the second place, the proprietor *guarantees the payment* of income on these loans, in the form of interest. This has two effects. The *risk of loss* of both interest and capital is assumed by the proprietor, and is guaranteed to the extent of his own resources invested in the business and even by his private capital. And as a consequence the lender foregoes any claim on profits in excess of regular interest. The second consequence is that this *interest must be paid* at stated intervals, hence, it may fall due before it has been earned and when income is deferred for long periods this may deplete the reservoir to a serious extent. The proprietor, whose total necessary investment of capital when he negotiates no loans is governed by the outflow of working capital on the right into the business, finds that when he borrows money he must frequently supply additional funds for this new drain on the left in the form of unearned interest on such loans. If he originally had to borrow any considerable portion of the capital this may prove difficult and may even force him into bankruptcy.

20. Relation of Proprietor's Profits and Borrowed Capital. — Aside from shortage of capital, or the tiding over of peak loads of expense, an additional reason for borrowing is the *desire to secure larger rates of income or profit by the proprietor*. The outflow for interest on borrowed funds is predetermined at a rate agreed upon. Hence all excess goes to the proprietor on the residual capital, e. g. if $10,000 is required for a business which earns 10 per cent or $1,000 and the proprietor borrows $5,000 at 5 per cent, he pays $250 interest, possibly in advance of income, but receives as his share a net of $750 which, on the $5,000 representing his own investment, gives him 15 per cent. On the other hand, the enterprise may earn but $250, in which case the proprietor receives nothing for the use of his capital as it must all go to pay interest on the loan. A still smaller rate of income or a failure to earn any income at all would mean a direct loss of capital by the proprietor to make good the loss of guaranteed interest. Inability to pay this interest leads to foreclosure and the taking of part or all of his capital by the lender in an effort to liquidate it for a value which will replace this borrowed $5,000. If this value of the loan is not realized, the lender's capital in turn

suffers depletion, thus emphasizing the fact that the risk applies to capital as such and can never be completely separated from any portion of it.

21. **Entrepreneur's Gain versus Profits.** — *Interest* is thus seen to be the *price of borrowed capital* and is not determined by income. Gross income must first cover expense, leaving net income, which may or may not be equivalent to a fair rate of interest on the total of both proprietor's and borrowed capital. All invested capital, whether borrowed or not, should be worth an equivalent price, hence the sum which this interest calls for may be regarded as the earnings expected by the capital invested.

For any economic purpose, such for instance as appraisal of the value of standing timber, borrowed capital must be disregarded and interest on the total capital investment is taken as the income to which capital as such is entitled. All net income in excess of this interest may be termed the *profits of the undertaking, or entrepreneur's* gain* and is compensation for risk and reward of skill and management. The *amount* of this excess earned over interest remains the same whether or not part of the capital is borrowed. The *rate earned,* including this entrepreneur's gain or loss, is computed for the total investment, including borrowed capital. The proprietor is at liberty to borrow any portion of the total capital which best serves his needs, and to divide the risk and profit as above indicated.

22. **Losses and Profits.** — On the books of the business, interest paid on borrowed capital is entered as a cost, or involuntary depletion of capital. Dividends are paid to the proprietor, not as a cost but as a voluntary withdrawal of surplus capital or earnings. In either case, such payments occur on the capital side and are returns to capital, which *must originate or be replaced from income,* or else they represent a mere exchange of capital, in which case the dividend has not been earned.

Payments of interest *out of new capital* are not only necessitated when proprietors borrow money to establish a business requiring more than one year for its completion, but are legalized in the case of major construction projects such as railroads, during the period of construction, since it is recognized that no other source then

* Entrepreneur (Fr.), one who undertakes the organization and management of a business enterprise for the purpose of earning profits in excess of the interest rate on capital.

exists from which to secure the guaranteed interest. But a continuation of such a drain after the time when the income should be sufficient to meet this demand means serious loss, and when extended to the declaration of dividends on stock or proprietorship it is a common means of attracting investors to fraudulent schemes.

The business statement therefor regards interest on loans as a cost since it neither stays in the business nor is paid to the proprietor in dividends. All net income over and above interest on borrowed funds is termed *profits*. Thus the profits of a business include the interest on the proprietor's capital. The distinction between *profits and entrepreneur's gain* is most important. The latter embraces only that portion of profits which remains after the entire capital, including the proprietor's equity, has earned interest at the standard rate. Profits are thus divided into interest and entrepreneur's gain. The latter constitutes the specific reward of enterprise, which would hardly be compensated in receiving only the bare returns which capital would earn without incurring the entrepreneur's risk.

In *economic accounting* and the determination of earnings of an enterprise as a whole, disregarding the distribution of ownership of the required capital, interest is classed as income on capital in all cases. Profit to be allowed in such an enterprise always includes interest. An excess *over* interest for entrepreneur's gain is of course permitted. But in no case is interest entered as a cost on which a profit should be earned; e. g. if the interest rate is 6 per cent and a profit of 20 per cent on the operation is agreed upon as the basis of appraisal of stumpage value, this does not mean that net earnings of 20 plus 6 per cent or 26 per cent are permitted in excess of cost, but that a margin for gain of 14 per cent is allowed, in excess of 6 per cent interest returns, or a total profit margin of 20 per cent.

23. **Cost Accounts.** — The *addition* of either simple or compound *interest to costs,* when money is not borrowed, is not permitted in business accounts. Returns of interest are not guaranteed to entrepreneurs. If the enterprise permits of borrowing, the interest paid *is* so entered, and only in such cases. Hence all calculations of so-called costs which include the addition to said costs of unearned and unpaid interest are not true or valid accounts of cost but are merely computations whose purpose it is to gauge the amount of the desired income, or to determine what net sum

must be earned before interest at the desired rate is assured. Thus the calculation of compound interest on actual costs serves a useful purpose in measuring the average earning power of money or cost of borrowing, and in indicating the loss through failure to earn this income, which is apt to be looked on as a cost in spite of the fact that no cash outlay is involved.

Many persons would be wealthy if they had the interest which has not been earned on capital lost many years ago in unprofitable ventures, forgetting that income is realized only through the successful efforts of entrepreneurs.

In *cost accounting,* the effort is made to allot to each unit of product both the specific costs or expense required in its production, and its share of the general or overhead cost. The purpose of such accounts is purely informative. Since the time required in production and period of investment thus necessitated for capital is an element of economic "cost" which becomes an actual cost to a borrower, it is permissible in such a cost account to compute compound interest on costs as a means both of comparing the respective costs of different operations *requiring different periods of time,* and to gauge returns and entrepreneur's gain. For this purpose in cost accounting and valuations based on cost, interest is often treated as a cost in forest valuation, as an aid to the seller in appraising the relative or personal selling price or in gauging his prospective entrepreneur's gain.

24. The True Nature of Interest. — The difficulty that has surrounded the treatment of interest should be made clear by Fig. II. The relation of interest is two-fold; to the capitalist, and to the business.

A *true cost* is an outlay of capital which goes into the dynamic processes of the business. Interest resembles this in only the *first phase* that it is an outlay or withdrawal of capital. It does *not* go into the business. It remains in the static, instead of the dynamic class, and is a return to capital, or a transfer of earned income from the coffers of the business to those of the capitalist. As income on capital it constitutes a prior lien on the business resources, being the "wages" of borrowed capital, hence in the accounts of the business it is entered as a necessary expenditure or "cost" which is the source of most of the confusion.

When its character as income on capital is fully realized there will be less likelihood of the continuance of arguments citing the

accumulation of compound interest to enormous totals as a reason for not undertaking the growing of timber. These totals represent not costs, but computed returns to capital. They are costs only in the sense that unsuccessful gamblers regard the money which they failed to make in speculations that did not materialize. The capital represented by such "costs" was never spent and had no existence.

CHAPTER III

ECONOMIC PRINCIPLES UNDERLYING FOREST FINANCE

25. Relative Versus Positive Values. — *The initial problem in Forest Finance is the determination of the actual value* of forest property as an investment. Upon the price paid for the property will depend to a large extent the *rate* of earnings or profit, the allowable costs of operation, and the success of the business.

Value is determined in one of two ways. Either it is based on *personal opinion* or appraisal, in which case there is room for wide differences, or it is indicated by *sales* of similar property, which tend to establish the market value of the property in question.

A sale requires an agreement between buyer and seller, and the property actually changes hands at the indicated value. Hence values so established are *positive* in character. But in the absence of sales, a buyer's value tends to be low, while that of a seller is relatively high. Appraisals of a given property made by these two respective parties would normally fail to coincide. Each is made with relation to the economic position of the respective parties. Values so determined are *relative and personal,* not positive.

26. Market Value. — *A purchaser* who is forced to pay the seller's full estimated value for property usually pays too much for it, in which case he must forego the prospect of realizing any entrepreneur's gain (§ 21) on the capital which he invests. He should therefore endeavor to secure the property at as much less than this value as possible. On the other hand, *the seller* of property or goods has a more or less accurate knowledge of past net costs and seeks a price which will cover these costs and in addition secure the largest margin of profit possible.

The purchaser or future owner will base his appraised value on expected *future use or income* from his purchase. To him, past costs of production are of no moment. They may be excessively high or abnormally low, yet he will be uninfluenced by them. What he seeks is the certainty of obtaining the satisfactions of ownership either in future profits or from direct use. To the seller *past outlay of capital,* including investment and operating costs, must guide him in determining a selling price, because the

securing of a profit is indispensable to the continuance of a business. If the price he asks yields an excessive profit, he justifies it not by cost but by value to the purchaser and prospects for future profits. This is the basis of many forms of swindling. It is for the purchaser to judge of the accuracy of such representations.

Market value is established by agreement between these conflicting forces. Prices, and the forces which fix prices, determine this value. Market value is thus usually higher than the vendor's appraised cost and will thus yield him a profit. This same price may be lower than the purchaser's appraised value and thus leave him a prospect for profit. The vendor's profit is definite, based on past costs. The purchaser's is probable or speculative, based on appraised value of use or future income, but is a none the less real element in price determination.

Market value, then, differs essentially from a relative or personal value set by an individual purchaser or seller, in that it is the *mean between two great social forces,* established by numerous agreements or prices arrived at between opposite pairs each representing one of these forces, and is, therefore, apt to be *more reliable as a basis of appraisal than any method of arriving at value by individual opinion independent of price.*

27. Use Value versus Cost Value. — A grasp of the nature of these two forces is of the greatest importance in understanding the problems of Forest Finance. They may be expressed as *Use Value* and *Cost Value* just as the resultant price established by agreement between them is termed Market or Sale Value. Use Value has other names such as Capital Value, Capitalized Income Value, Expectation or Expectancy Value, and Capitalized Rental Value, but in each case the value is based entirely upon the value of the *probable future use,* as may be measured by income or "rental" and is found by discounting this future net income to the present moment, or as commonly expressed, by capitalizing the income. On the other hand, cost value has to do entirely *with the past,* and is obtained by totalling the past net costs and bringing this total up to the present. This relation or tension of forces in reality determines all values. Use value is vital to the existence of the future owner, and thus by analogy to the entire community. Yet the future cannot be foreseen but only vaguely predicted, hence this value cannot be mathematically determined but can only

be approximated. By contrast, cost value can be determined with mathematical accuracy if based on proper records, yet if the property is devoid of any future use these past costs will have no influence whatever on market value. As a consequence, the expenditure of energy as expressed by costs is constantly being redirected towards objectives of greatest utility for the reason that only in this way can the producer ever hope to be adequately compensated for his efforts by continuing to secure profits.

The forces which determine value are brought most sharply into focus in the purchase and sale of finished goods ready for immediate consumption. Here the cost of production is complete, and capable of determination by the seller, while the purchaser need consider no future intervening costs which must be deducted to get actual present use value. When the value of productive property is sought instead, the value of the products lies largely in the future and the relative importance of past costs already incurred shrinks proportionately. Thus we find that in appraising the value of the land or of timber stumpage, past costs or investment have very little influence upon present market value.

28. Monopoly values. — The price of finished goods as determined by the relations between buyer and seller of these products indicates the future value of the income on which capital value of property depends. But in the sale of this property, although it is so largely based on the future, these same elements of relative strength of buyer or seller are important.

This tension manifests itself in the relative advantage or ability to secure their respective personal estimates of value possessed by the two respective parties, which always results from the absence of free competition, or creation of partial monopoly. The laws of *marginal utility* and *marginal cost* respectively set the upper and lower limits of price range or market value. Marginal cost sets the price at which the least efficient producer can continue in business, all more favorably situated producers obtaining a margin of profit over their own costs by selling at this price. For the consumer the marginal utility price is that fixed by the value to him of the last or final unit of the available supply of a desired product or goods which he feels he must have at that price. If he has to pay more than this he goes without, and this tends to lower the price level.

In Fig. III it is seen that a lowered price will increase the number of purchasers while a rise in prices encourages a greater number of less efficient producers to continue in business.

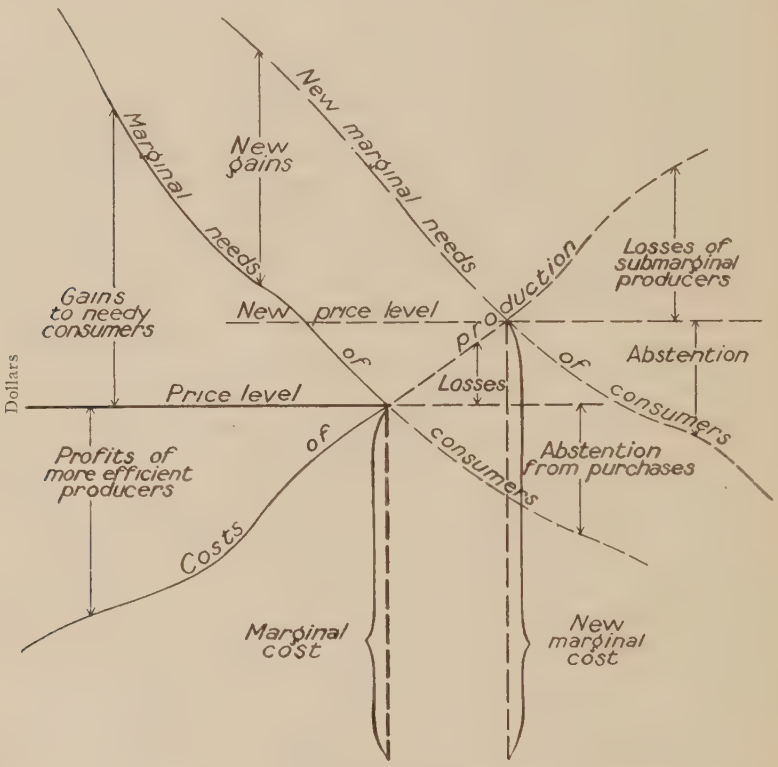


FIG. III.—The inter-relations of marginal costs, marginal utility and market prices, in regulating production and consumption.

The element in each case which tends to direct prices towards a level favorable to one or the other of these parties is the *discontinuance of production or of consumption* respectively by individual units, while the opposite result attends the increase in the number of these active units.

This negative force constitutes a resistance to unfavorable price changes, and tends to put the opponent at a disadvantage. It is termed *monopoly strength* and is possessed to a greater or lesser

degree by every consumer and every producer. Since the presence of other producers or consumers tends to weaken the effect on prices of the abstention of any one individual, active competition or open markets best serve to equitably balance these two forces, while the monopoly strength of an individual unit is greatest when competition in its own field is least, and in the opposite field, is active. Public service monopolies usually require price regulation for this reason.

Macfarlane* says, "The point within these upper and lower limits at which price is actually fixed is indeterminate since it depends on the relative monopoly strength of buyer and seller. *The phenomena of price cannot be reduced under any exact law.*"

The importance of price as an index of value can easily be perceived since it registers the results of these two great forces whose tension or balance determines value.

29. **Relation of Use, Cost and Market Values.** — It is thus seen that value is a social product, the resultant of two well-balanced forces held in tension. Appraisals of value may be based entirely on either of these forces to the exclusion of the other, and termed respectively, use value or cost value, but *neither will represent established, or even dependable values.* To accept use value as final would be to substitute individual speculative opinion in place of demonstrable facts. This basis is further prejudiced by the difficulty of agreeing upon a *rate to use in discounting* future values to the present, an indispensable process. Although defended with great vigor as the only scientific basis of value, its uncertainties and eccentricities have proved so great that more recent authorities are voicing such sentiments as "the so-called valuation according to revenue is impracticable, unscientific, and indefensible."† In the same way, to *accept cost value* unchanged puts a premium on inefficiency, for costs vary not only with opportunity or favorable circumstances and conditions, but also with human skill, and to nullify the advantages of both these differentials, and declare that the most costly unit of identical goods is the most valuable, or that the least efficient producer shall be rewarded by an excess price on his product, would be fraught with

* Value and Distribution, Charles William Macfarlane. P. Lippincott, Phil. 1899, P. 307.

† The Value of Landed Property, Frederick Aeroboe, Bul. International Institute of Agriculture. No. 10-12, Oct.-Dec. 1912, P. 2343.

serious danger to society. *Sale or market value, then, is the balance* which keeps both forces in proper tension and assures their beneficial reaction.

The true utility of appraising use or cost values is to enable the purchaser or seller to judge as to the probable or the actual amount of entrepreneur's gain (§ 21) to be anticipated or realized by each, respectively, from a sale at a given price.

Accumulating costs terminate to the seller on the instant of completing the sale. Discounted future income is concentrated or

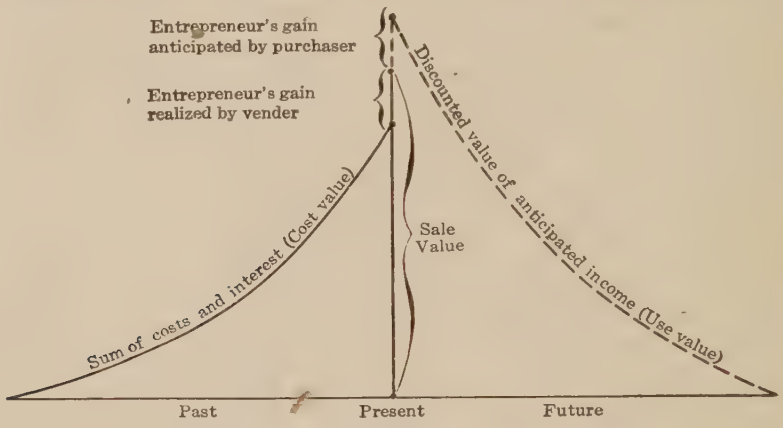


FIG. IV.—Relation of cost value, use value and sale value.

capitalized, for the purchaser, at the moment of purchase. The relation of these forces is shown by Fig. IV.

It is evident that a sale may and should *benefit both parties,* and that when the price is such as to completely deprive either party of his profits, economic loss is suffered by diverting the rewards either of past or of future enterprise to one who has not earned them.

30. The Law of Rent or Marginal Values. — *The economic theory of rent* is of great importance in understanding the influences which determine the value of forest crops or timber stumpage and of forest land. As applied to the value of land or its use for a specific purpose such as agriculture, this theory holds that the price paid for land or its rent is dependent on the earning power of the poorest land actually under successful cultivation. Such land can be said to earn no rent and to represent *marginal values*

in agricultural production. Much evidence of late in the United States seems to indicate that large areas of land brought under cultivation by pioneers have now become *sub-marginal* and these lands are being progressively abandoned. As land of better quality produces crops at lower cost, the difference in cost, or the margin, forms the basis of the rent paid for such lands, and the capitalization of this income tends to establish the sale value of the land.

This economic principle is equally applicable to *raw materials*, of which *timber stumpage* forms a conspicuous example. In fact, it is by an understanding of this law of marginal values that far-sighted owners of timber lands have reaped large profits through being able to prolong their cut until a new price level had been established by the migration of most units of the lumber industry to more distant fields whose increased costs of logging and transportation then became the marginal costs for the former region of depleted supply.

Stumpage prices for second growth timber in New England, which for white pine were in 1923-24 three to five times as high as for the finest quality of Douglas Fir in Oregon, showed this differential because of the operation of the law of marginal values in a community in which the local supplies are far short of the demand and marginal costs on Douglas Fir include that for transportation.

The changes in values or prices of land or raw materials to which the law of marginal values or rent gives rise does not affect prices of the manufactured product in any way, but instead, these changes are derived directly from the market prices of the products as established by the tension between marginal utility values and marginal costs of production. Therefore, the *price or value of timber stumpage* is ultimately derived from the price of lumber, and the price of stumpage neither increases nor diminishes lumber prices, but, instead, represents a marginal return to the more favored owners of stumpage similar to land rent or to any other margins.

Forest land in turn derives its use value from timber stumpage, hence is affected by this same law of marginal values to an even greater degree. It is impossible for the cost of forest land to affect the price received for the timber grown upon it. Instead, the net income received from these crops, as compared with that obtainable from lands of other qualities, location, and markets,

will be the determining factor in indicating the use value and, through sales, the market value of such lands for forestry purposes.

These tendencies may be put in the form of an equation as follows: residue for stumpage and land values equals market value of finished products minus manufacturing costs and profits minus logging costs and profits.

This indicates why lumbermen in the past have attached very little value to the land. Stumpage represented to them the ultimate marginal value. When the business of forest production is undertaken, the equation is extended and residue for value of land equals stumpage value minus cost of producing timber and profits. This residual value of land for forest production thus reflects the relative profits from forestry in different regions.

31. The Forces Which Determine Value. — *Fluctuation of Values.* — Market value is measured by a *money standard* which acts as a common medium of expression. Personal or relative values need never be expressed in money except as a basis for sales, and the most valuable of human possessions are beyond the reach of a monetary standard. Even the material products which are commonly exchanged depend for their value not on their physical qualities but instead on the uses and benefits which these qualities fit them to render to man, and on mental estimates of the relative desirability of these benefits. All *values* exist literally in men's minds as the result of the reaction of ideas based on human needs both mental and material. The play or tension of the two great forces represented by buyer and seller is continually determining prices.

The present moment. — Market values or sale values thus come nearest to expressing the most commonly accepted ideas of money value for a specific property at any given time. But this time is always the present moment. For a future time, values must be redetermined when that time arrives.

The source of value is twofold. Primarily, it is *use or benefit* (§ 27). But if this gratification can be obtained without effort in unlimited quantity, there exists no measurable value. *Effort or cost* completes the tension of forces and the power of this tension is recorded as value.

The constant tendency of this process is to force values to a more or less close *adjustment* to a real or fair measure of benefits or relative desirability. But no one should pretend that even market

values ever exactly reach or long remain coincident with so-called "real" or "intrinsic" value. Such value cannot be determined mathematically by any known means. The best we can do is but an approximation. Present market values may prove in the near future to have been far astray. It is always the privilege of the individual to make his own personal appraisal of value and be guided accordingly, profiting if possible by the failure of the public to foresee the trend of values.

Speculative values. — Market or sale values being based on actual sales, which are in turn the expression of mental estimates of value, are at times stampeded by forces which have little relation to underlying facts or values. The corrective of such false values is experience, which shows that the expected benefits or income are not forthcoming.

Appraisals. — It follows that values should be determined on the basis of full information on the part of the purchaser as to his anticipated income, and of the vendor as to his costs. Ignorance on the part of either party tends to a false adjustment of market values and violent, injurious oscillations of prices which retard industry and development.

CHAPTER IV

THE MEASUREMENT OF TIME VALUES IN FORESTRY

32. The Influence of Time on Values. — A personal appraisal of value by purchaser or by seller means the *summing up* at the present moment of the total of future benefits or income expected, or of the total of past costs respectively. In either case, the elements to be valued extend over *a period of time,* which may be of considerable length. In any one instant or day, the amount of effort expendable and the measure of satisfaction achieved are limited by time. Cost increases according to the duration of this expense, and the value of use in turn depends in a great measure upon its permanence or continuation. Time serves as a measure of the total quantity and value of either cost or use just as it would in gauging the flow of a stream through a weir.

Time alone does not add to value. Instead, any increases in material values are due to the dynamic natural forces of growth from the soil or the energy released from fuel or harnessed water-power, directed, controlled and supplemented by man. The value of a specific property may be increased either by applying such forces directly to it, using or improving it, or it may accrue as the result of similar use or improvement of adjoining property on a large scale, accompanied by the development of transportation facilities and markets, giving rise to the so-called *unearned increment.* Back of this element lie changes in local population or in habits and preferences. This may work both ways, either to increase or decrease values.

33. Dependence of Value on Utilized Energy. — *Interest is the measure of value of money when in use.* Owners of property which is non-productive often reckon the income which they believe they should ultimately receive by comparing it with the income which such money should have earned if put at interest. But in assuming that such calculations indicate the value of their property they make a vital mistake, for money itself would not increase when lying idle in this manner, and the unearned increment is a product of forces for which the owner is not responsible and which may operate in a negative direction. Even when basing

increased value on outlay, the physical improvements and not the time element are the source of increase in this value. *Time unaccompanied by either individual or social effort* usually has the opposite effect as is seen in the rapid deterioration of all forms of property which are not used or cared for.

Owners who believe that there is any economic law which assures them *compound interest* on cost over considerable periods of time, without effort but merely from the act of holding or ownership, are nearly always forced eventually to accept considerable losses if through no other source than taxes and current expense, and if finally returns from unearned increment are secured, the rate of compound interest realized on all expenses is apt to be low compared with the use of funds in active enterprises.

By contrast, the harnessing of the productive forces of the land by growing crops of timber usually assures the owner a reasonable return independent of the possible realization of unearned increment.

These conditions apply with even greater force to present capitalized values based on future use. Time alone invariably *diminishes* the present value of future income, because of the fundamental condition that the present moment only can be actually realized. A hungry man sets a proportionally greater value on to-day's meal than on one promised him next week. The further removed any future income is, the less will be its present value. To find this present value, the future value is reduced by a given ratio, or discounted.

If the future net income is continuous for a given period, the entire sum of this income must be considered and each item discounted, the total giving the present value of the income and of the property producing it. This so-called capital value may exceed that of a single payment of income in spite of this shrinkage or discount, provided a sufficient number of later payments are guaranteed at fairly short intervals. But the value of the property at present is always very much less than the sum of the expected income on which this value is based, e. g. an income of $1.00 per year at 5 per cent is worth in theory $20.00, but only if these annual payments continue indefinitely. If they cease with the 20th payment, their present capital value is not $20.00 but a lesser sum, which in this case at 5 per cent discount would total but $12.46 (§ 57—III).

But *back of this income must lie work* or energy of production in the future as in the past. No future income is automatically guaranteed. The discounted or capital values of such appraised future incomes rest on the reliance of the investor on the continuance of these productive energies, either under his own guidance or that of others. The discount expresses the influence of time plus the uncertainties of the future. Neglected or unutilized property comes to have a negative value both to the owner and to society through the absence of these creative forces. Supine reliance on unearned increment fails when shared by the community as a whole, and we have the phenomenon of entire counties bankrupt and pauperized through the failure to grow timber on cut-over lands.

34. Simple Interest and Discount. — Since money is the standard of value, the *discount* charged for cashing notes in advance, which are payable at a future date, establishes a *standard or ratio* between present and future values which influences similar computations for all forms of property.

This discount ratio is practically identical with the rate of interest, or the sum charged for the use of money for one year, which is expressed as a per cent of the principal. Either as discount or interest, it represents the charge for the use of money capital for a definite period. The amount of the interest or discount should coincide with the difference in value of a sum of money received now or at a future date.*

The formulae used to express the relation between principal and interest or discount are:

V_0 = Present capital.
V_1 = Capital at end of one year.
p = Rate of discount or interest. (Some authorities use t to represent this value.)

Thus
$$V_1 = V_0(1 + p)$$
$$V_0 = \frac{V}{1 + p}$$

* A common banking custom is to use both the interest and discount rate as applying to the face of a note, by which the discounted value is slightly lower than the true discount rate requires.

Since p represents a value which is a decimal of 1, it is better expressed as:

$$\frac{p}{100} = .0p$$

e. g.
$$\frac{6}{100} = .06$$

The formulae then become:

$$V_1 = V_0(1 + .0p)$$
$$= V_0(1.0p)$$
$$V_0 = \frac{V}{1.0p}$$

e. g. for 6 per cent:

$$V_1 = 1.00(1 + .06)$$
$$= 1.06$$

35. **Compound Interest and Discount.** — *Interest upon invested capital,* when paid, may in theory be promptly reinvested and *will in turn earn interest,* thus becoming incorporated as part of the principal or capital. This capital sum thus increases annually at a rate represented by a geometric progression, whose factor or multiple is 1 plus the rate of interest, or $1.0p$.

By contrast, if interest earned is saved *but not reinvested* or put to work, the principal plus accumulated interest increases in an arithmetic progression represented by the addition annually of the interset, which equals $V_0(.0p)$. In this case $V_n - V_0$ is the *simple interest* earned by a fixed capital; or the amount which an investment earns in a given period when the income is produced annually but not reinvested.

A third alternative, and the most common, is to withdraw or expend the interest earned. This leaves the principal intact but without increase. The difference between these forms of investment or treatment is fundamental and a clear understanding of the nature of the contrast will explain the character of most investments in forestry. The elements of difference are two, namely, *saving or abstinence,* and *reinvestment.* Assume three sums representing these alternatives, equal at the start, with equal earning

power. Each sum yields its income annually. The difference resulting arises from the voluntary relinquishment on the part of two of the three owners of the pleasure or satisfaction of spending their income. This is the principle of *abstinence* which is the basis of the institution of capital. Without such saving the original capital cannot increase. The second principle, of *reinvestment,* means simply that for the third sum this saving is accompanied by investment or use of the income. This difference is seen in the choice of giving the use of this income to a bank which earns and pays interest instead of locking it up in a vault or deposit box.

In the case of money on deposit in savings banks, the owner has free choice of withdrawal at any time. The full earnings at compound interest will be obtained only if he abstains from touching any portion of the accumulating sum and provided the community continues solvent and the bank earns and pays the interest on the money.

In any other form of investment or in any undertaking requiring use of capital in production, either of these three conditions may hold. If dividends are taken annually to the extent of the profits, capital invested remains stationary in amount. If, instead, the earnings are reinvested, this abstinence *when accompanied by continued earnings* should result in increasing the capital at the geometric or compound rate. The undertaking may be of such a character that the earnings are not produced annually, but must be awaited for several years. In this case the abstinence is involuntary or enforced. The investor commits himself to this policy when he first undertakes the enterprise. He may expect as his returns the same increase at compound interest which he could have obtained by equal abstinence in other operations paying annual income. Forest plantations are examples of this form of investment. Compound interest is for this reason advocated as the measure or gauge of the rate expected on investments whose income is deferred for periods exceeding one year.

The formulae for compound interest and discount are based on the theory that the interest earned in a given year is automatically reinvested as interest-bearing capital for the succeeding year without cost or loss of time. Then since,

$$V_1 = V_0(1.0p)$$

End of the second year:

$$\begin{aligned} V_2 &= V_1(1.0p) \\ &= V_0(1.0p)1.0p \\ &= V_0(1.0p)^2 \end{aligned}$$

End of the third year:

$$\begin{aligned} V_3 &= V_2(1.0p) \\ &= V_1(1.0p)1.0p \\ &= V_0(1.0p)^3 \end{aligned}$$

from which, for any year or period, n,

$$V_n = V_0(1.0p)^n \qquad \text{I}$$

and by discount

$$V_0 = \frac{V_n}{1.0p^n} \qquad \text{II}$$

e. g.

$$\begin{aligned} V_0 &= 5.00 \\ p &= 6 \text{ per cent} \\ n &= 20 \text{ years} \\ V_n &= 5.00(1.06)^{20} \\ &= 5.00(3.2071) \\ &= 16.04 \end{aligned}$$

and

$$\begin{aligned} V_0 &= \frac{16.04}{1.06^{20}} \\ &= 16.04(.3118) \\ &= 5.00 \end{aligned}$$

When the rate p is agreed upon or fixed, this determines the ratio and indicates the exact future mathematical equivalent of a present value, or vice versa, for any period of time.

36. The Present Moment as the Basis of Valuation. — Since value has no concrete or real existence except in the present moment, any appraisal of value for the benefit of a buyer or seller is intended to aid in determining this value at present, and is obtained either by discount from the future or by adding interest to past costs. E. g., the sum of $5.00 is placed at interest at 6 per cent. After 20 years it should have a value of $16.04. Of this sum $11.04 would represent interest on $5.00. Simple interest for 20 years at 30 cents per year would yield $6.00 and com-

pound interest exceeds this by $5.04. If this investment was made 20 years ago and the interest actually earned, the actual value now is $16.04. But if we seek the value of a sum of $16.04 which is not payable before 20 years have elapsed and 6 per cent is the rate, this value is discounted to $5.00 at the present moment, based upon the assumption that the future payments are assured.

When the value of the prospective yields of forest plantations is computed for the end of a rotation or crop period of n years, this does not indicate the value of the young trees or investment, for value is what the plantation is worth now, not in n years. The assumption is that this plantation *may* be worth that amount some day, provided it grows properly, is not destroyed, and the product is sold for a given price. Even if this result should be guaranteed, which is impossible, the corresponding present value cannot be calculated unless we also know or can agree upon the rate of discount to use in adjusting the time difference in value. A value thus derived is evidently a mere appraisal representing relative or personal opinion (§ 25) and not market value, but it is of material aid in the successful negotiation of purchases or sales.

37. Determination of the Rate Earned. — Since the *rate of interest* or discount determines the ratio existing between two values separated by a definite time interval, it follows that when these values are already known or assumed, *the ratio in turn can be found* which permits the conversion of one value into the other, thus indicating the earning power and rate of profit yielded by the investment.

If the values of the capital sums at the beginning and end of the year are known, the ratio or rate earned may be found:

Let $x =$ Rate earned.

$$V_0(1.0x) = V_1$$

$$1.0x = \frac{V_1}{V_0}$$

$$x = 100\left(\frac{V_1}{V_0} - 1\right)$$

e. g.

$$5.00(1.0x) = 5.30$$

$$1.0x = \frac{5.30}{5.00}$$

$$x = 100(1.06 - 1)$$

$$= 6 \text{ per cent}$$

The general formula for determining the rate earned at compound interest for a period of n years is

$$V_0(1.0x)^n = V_n$$
$$1.0x^n = \frac{V_n}{V_0}$$
$$1.0x = \sqrt[n]{\frac{V_n}{V_0}}$$
$$0.0x = \sqrt[n]{\frac{V_n}{V_0}} - 1$$
$$x = 100\left(\sqrt[n]{\frac{V_n}{V_0}} - 1\right)$$

e. g.
$$5.00(1.0x)^{20} = 16.04$$
$$1.0x^{20} = 3.2071$$

The tabulated values, for 20 years, for the formula $1.0p^n$ will indicate the per cent which most nearly coincides with this ratio. Otherwise the solution is by logarithms.

$$1.0x = \sqrt[20]{3.2071}$$
$$\text{log. } 1.0x = \frac{\text{log. } 3.2071}{20}$$
$$\text{log. } 1.0x = .025305$$
$$1.0x = 1.06$$
$$x = 6 \text{ per cent}$$

38. The Time Element in Investments in Forest Production. — As a rule, the longer the time required to bring an undertaking to completion so that the services for which it is intended can be rendered, the greater should be the value of those services to the public. The establishment of agriculture in place of the chase required time and capital, and the protection of the capitalist and of property. In modern industry, the gigantic engineering projects by which transportation has been secured, modern buildings erected and manufactures organized, are made possible by the increase of capital by which the time of wage workers can be utilized for long periods in initial construction. In all such engineering works there exists a ratio between time and effort, in that the time for construction can be shortened within a given limit by increasing the number of workers.

When dealing with natural forces for the production of raw materials in the form of wood, modern society has undertaken operations which are time-consuming beyond any previous human experience. In forestry, the *element of time is not readily interchangeable* with labor or expense. The period can be shortened by improved methods of culture but only within prescribed limits.

The characteristic feature of the capital investment in forest production is not quantity expenditure, but *abstinence, or the willingness to wait* the maturing of income. The required outlay of capital is comparatively small; the final returns or ratio, by direct comparison, very large. But the length of the period reduces the rate of earnings at compound interest to a reasonable or even small per cent. Time to permit of the operation of *natural forces* is the chief requisite in forest production and the expenditure of large amounts of capital cannot be substituted for foresight and patience, but would only have the effect of destroying all prospects of profit. This sometimes happens when ill-advised investors endeavor to speed up forest production by expensive cultural improvements suitable only for parks.

39. Importance of Annual Income and Sustained Yield. — Although the period required to produce crops of timber is long as compared to that in other human industries, the exercise of foresight and business sagacity is capable of eventually overcoming this handicap and placing forest production on the same basis of *annual income and dividends* as any other enterprise. To attain this objective it is necessary to so order the management of a forest that crops of timber will reach maturity successively in each year.

When attained, this condition enables the business to be conducted on the basis of annual income and expenditure, and the net income may be gauged according to its relation to the capital invested in the entire forest. This result is the goal of all rational forest management and is the urgent reason for endeavoring to create or retain these conditions in the management of forest properties from which the natural forest capital has not as yet been so far depleted as to prevent regulation by the owner to secure a sustained yield and income.

40. Rates of Current or Annual Income. — On an entire forest, or on any stand or crop within it, it is possible to gauge the *rate of interest which is earned,* provided we know the approxi-

mate value or cost upon which this should be based. The current interest rate depends first, upon growth of wood; second, upon increase in quality; third, upon general price increment for forest products. For a forest, from the sum of these increments expressed in money value is deducted the annual expense of maintenance. The net increment indicates the per cent which is being earned upon the capital invested in land and timber.

The per cent of increment may be expressed as, either

$$V_1 = V_0(1.0a)\ (1.0b)\ (1.0c)$$

or, as is more commonly used,

$$V_1 = V_0\ 1.0(a + b + c)$$

For the forest, the financial per cent earned would be:

$$x = 100\left(\frac{V_1}{V_0} - 1\right)$$

In which V_1 is derived by adding to V_0 the annual increase in value and subtracting the annual cost or outlay.

CHAPTER V

THE DETERMINATION OF PROFITS IN LAND ENTERPRISES

41. The Basis for Values in Land. — *Recapitulation.* Income and capital are intimately bound together, the ratio between them being the rate of interest paid or the rate of income earned (§ 10). Values are most nearly approximated through sales, establishing market prices which are the resultant of the tension of the two collective opposing forces of producer or seller and consumer or buyer (§ 26).

Relation of buyer and seller of lands. With finished products, consumers are identified with buyers, and producers with sellers or vendors. But with raw materials, the buyer consumes them only in producing finished goods, while with land there is no consumption and buyer or seller must use it for *similar or identical purposes,* i. e. some form of production for which it is best fitted.

Values for natural resources such as forest land are determined by the tension between buyer and seller, just as are other prices, but there is an essential difference in that the seller does not usually have to dispose of the property, but can retain it and realize the income, hence has the same basis for valuation or price determination as has the buyer. He is *not selling products* which is income, *but capital itself,* which is ownership, and carries with it the right to realize all future income.

The seller in this case is actuated to a far greater extent by the character and *value of the income* which this property will yield than by what the property has cost him. If he is so inexperienced as to attempt to base his sale value on cost, adding the carrying charges, and then including the interest which he would have earned if he had loaned the equivalent in money, he may rest assured that the purchaser will in no case except through ignorance accept such value, but instead will closely examine the basis of future net income.

Past costs serve but one useful purpose in valuing landed property, that is when as operating costs they indicate the probable future cost of producing the income, and thus aid in appraising net profits.

Future use or profits are thus the outstanding factors which interest owners of real property, whether they be buyers or sellers. Profits must eventually come from the income of the use of land. Profits derived from sales of land if not justified by possible net income are speculative, one man losing what another gains. The real basis of land valuation is a careful appraisal of the probable net income and its discounted value at the present moment.

42. The Two Sources of Profit. — Profits may be realized in one of two ways, *by earning* them out of developed enterprises, or *by selling* the property at values which capitalize anticipated income not yet earned (§ 11). The first process tends to develop the highest qualities of the race and makes for its prosperity and civilization. The second constantly tends to *destroy* industry, deplete savings and transfer the profits of enterprise to those whose only contribution to society is the ability either to outguess or to deceive their associates as to future values. Yet it is as impossible to dissociate these two processes as to separate the good and bad in human nature, and the transfer of property based on its *capital or true sale value* is as essential to industry as the processes of manufacture. Where purchasers make mistakes is in overestimating the value of probable income in the competition to secure property which is being boomed by vendors. In typical speculations, the buyers frankly admit that they expect their *profits from a resale,* and not from development, which is why such booms collapse. Without development and earned income, speculation crashes of its own weight.

43. The Investment Basis for Computing Profits. — The *ratio* of net earned profits requires for its base *a given investment,* which is assumed as fixed in a *given year of origin* (as for instance the year 1913 in United States income tax appraisals of stumpage value). This year may be that of the original organization of a business, and the fixed value that of the capital subscribed at that time. Or the capital may represent the original purchase price of an enterprise consisting of land to be used for the growing of timber. Whatever the basis, it is impossible to express profits in a comparative form or ratio similar to that of interest earned unless this *initial value of the capital is known or fixed.* This value must be the sum actually paid for the property on the date from which profits or earnings are to be computed. Any greater initial value placed upon the property or capital at

this date conceals the true profits of the subsequent period, which are contained or buried in this assumed value. It is perfectly legitimate to *revalue capital* at any time subsequent to initial purchase, if it is recognized that the difference between the old and the new value represents assumed or admitted profit or loss, but such profit is not actually realized in income until a *sale* is made. *A new basis for future* calculations of profit is then established. Such a re-valuation was made necessary in 1913 on timber-lands which had been purchased in previous years and upon which it would have been manifestly unfair to have reckoned the profits of different owners from the period of original purchase whenever that may have been. Any past profits were thus taken up at that time.

Reorganization of a business, or recapitalizations, are merely the means of readjusting capital values to a *new basis* for computing *future rate* of profits. Stock dividends are a form of this process. To increase face value of capital obviously reduces the ratio of earnings and to reduce it increases said ratio, which is what happens in reorganizations of over-inflated enterprises.

44. Changes in Values of Capital Invested in Land. — The initial investments in property can *never remain at their original value.* It would be as reasonable to hold that the price of wheat should remain what it was on a given day ten years ago. Values are determined by prices and capital subscribed to a business is invested in land, buildings, materials and wages the prices of which are constantly changing. The prospect of income from the use of the land and the value of a going concern all tend to influence *value of these capital assets* of the business. This simply means that *prospective profit* is having its usual effect on value of the capital investment and that it is always possible to *take these profits,* without waiting for them to be earned, by simply selling the enterprise as a whole, or to *take a loss* and thus terminate a losing venture by the same method.

Changes in the value of forest property are due to at least *five factors,* most of which tend to increase values. These are:

1. *Physical growth* of the trees in size and increase in yield per acre. This is the greatest factor of difference between virgin timber and second growth. In the former, the volume per acre is usually decreasing, sometimes with alarming

rapidity, causing great losses such as were incurred in the South in 1925 through drought, in Longleaf Pine.

2. *Improvement in quality* of a given unit of volume such as the board foot. This occurs through the laying on of clear lumber as trees become larger and lose their lower branches, and through the production of larger sizes.

3. *Increase in unit price* of a given quantity of output. This "unearned increment" results from increasing scarcity of wood compared with other raw products.

4. *Increase in the margin for stumpage value,* which results from diminished cost of logging through improvements of transportation and logging methods.

5. *General price increment* due to the depreciated value of money.

The ratio or annual per cent represented by each of these elements of change in value of the capital may be roughly approximated over a term of ten or more years, or predicted from a study of past changes, and reduced to an annual average percentage which is never very accurate.

Growth, or loss, is measured on the area by approved methods (Chapman's Forest Mensuration, Chapters XXII-XXXII) for periods of at least ten years.

Quality increment may be obtained by mill scale studies of the grades of logs of different sizes and character, and the results applied through growth studies (ibid., Appendix, page 461). Prices of lumber are best predicted from curves based on the trend of past prices, taking into account all known predictable factors.

Increase in margins for stumpage depends on many unpredictable factors one of which is wages. If cost of logging and manufacture increases faster than lumber prices such margin decreases.

45. Effect of Monetary Changes. — The idea of the permanence of value of a fixed sum of money deposited in a bank has been exploded in the popular mind by the recent *fluctuations of the value of various currencies.* The apparent profits earned on investments made before the war, while correctly reckoned in money, shrink to about 60 per cent when gauged by the standard of commodity value.

A *change* in the value of money has two effects on the problem

of computing the ratio of profits. First, it *distorts this ratio,* as shown above, a depreciating currency making the rate appear larger than it really is, and vice versa. Second, it *benefits debtors,* borrowers and owners of property of all kinds other than money, and correspondingly *injures creditors,* or lenders, investors in bonds, and those who receive fixed salaries that are not adjusted to the change in value of the standard. Profits computed on a pre-war base are in reality no greater because of this shift in money values. Post-war valuations on the basis of new currency values adjust the basis of profits to the new purchasing standard of money. Any computation of the *rate of profit in forestry* for a given problem can safely be made on the theory of a stable value of currency, since when corrected by the index of purchasing power, the only economic effect of such fluctuations on profits is upon the problem of credits or loans (§ 20).

46. Factors Determining the Rate of Profit. — The computation of the rate of profit therefore applies only to a given period for a given investment (§ 43) and will *include two factors,* first, the *net income* for the period itself, and second, the *re-valuation of the capital* at the end of the period, which in reality is the effect of *future* probable profits upon values and prices in that year; therefore,

Profits = Net income ± Final difference in value of fixed investments.

This last member of the equation is what causes the most trouble with uninformed investors. Especially do the less experienced sawmill men overlook the factor of depreciation of equipment, basing their profits on the net operating income. On the other hand, the investor who buys stumpage of a character and in a region where he hopes the rise in value will beat out the carrying charges understands fully the importance of increasing value of the capital as a basis of profits, and in appraising probable future profits from timber for purely personal information (§ 25) such increases in future stumpage values are used as the judgment of the appraiser approves. It is possible also to attempt to approximate the probable increase in land values as a source of future profit. In forest investments this is not usually done, but the land is entered as a final asset at its present value. Land, especially forest soil, can be managed so as to maintain its fertility and productive value forever. Depreciation therefore does not affect land

values as an incident to use. A common practice in forestry is therefore to compute profits solely on the basis of the net income from the timber crop, omitting possible gain or loss in value of the soil. But, as will be seen, these gains or losses in value are unavoidable and must usually be reckoned with in forest valuation.

47. Average and Deferred Profits. — For an active business with a fairly regular *annual income* the problem of the *per cent of profit* earned annually is relatively simple, but this is never the case in a forestry enterprise. A lumber manufacturer may after a fashion compute his annual earnings, but not without very careful estimate of depreciation of equipment and depletion of stumpage. Usually the *profits are never fully known* until the entire operation is closed, and the land holdings are sold or written off as a loss. Increasing net returns from year to year is the usual course of such a business if successful, but a large part of the gross income is mere *withdrawal of capital* to cover depreciation (the entire investment in land, timber, and plant must ultimately be so withdrawn) and the true net income may be due largely to the increase in the value of the stumpage, from the enumerated causes.

It follows that the annual rate of profit or net income is much more difficult to determine for any business than the *average or total results over a term of years;* in which both factors, net actual income, and change in capital values, can be better approximated.

48. Income Earned versus Income Withdrawn. — *Income earned and income withdrawn are not synonymous.* In theory, the income withdrawn should coincide with the income earned, but as shown by Fig. II this withdrawal is a voluntary or optional process, and it is just as easy to withdraw less or more than the earned income as to balance the two, especially when the actual net earnings are difficult to measure accurately. If less is withdrawn, the capital increases and vice versa. The temptation of private owners, especially of those with small means, is to *realize dividends,* and the income thus received affects their idea of the value of the capital more directly than do the actual net earnings, whereas these payments may, if in excess of earnings, undermine the earning power of the business for the future or even wreck it. In no business do these principles apply with greater force than in *forestry or wood production,* where the capital of the enterprise must consist largely of the standing timber of all ages, and the earned income is represented by the growth or increment of wood

laid on annually. The cutting of this wood is in the nature of withdrawal of dividends, replaceable by annual growth. Far more wood capital exists in a normally stocked forest than is represented by one or by several year's normal growth. Yet this wood capital is easily withdrawn by a logging operation which may pay no attention to wood production as a business. Even when forestry is the basis of the enterprise, the tendency for dividends constantly tempts the owners to *over-cut the forest,* reduce its capital and lessen eventually the average annual income, in the belief that they are making greater profits. The profits made in destructive lumbering represent for the most part a mere liquidation of stored-up capital in virgin timber, leaving a ruined asset in its wake.

49. The Comparison of Profits on Basis of Annual Rate Earned. — Profits may be classed as realized profits, and anticipated profits. The former are determined from records, the latter by appraisals. Realized profits are the basis for appraisals of anticipated profits.

If profits are to serve as a guide to investors both as to values of property and guidance of industry, the sums, realized or estimated, representing profit must be reduced to a common basis of comparison, which is the annual rate earned per dollar invested. These annual rates must be found for the following conditions.

For realized profits:

From annual net income.
From deferred net income.
From appreciation of value of property
Realized by sale
Reappraised and added to surplus.

For anticipated profits, or appraisals:

Of future net income.
Of future appreciation in value of property.

Determination of rate earned annually by net income needs no explanation.

Let

$r =$ annual profit
$I =$ invested capital
$x =$ rate earned

$$x = \frac{r}{I} 100$$

e. g. An investment of $5,000 earns $500 per year.

Then $$100\,\frac{500}{5000} = 10 \text{ per cent}$$

Where income is deferred, or where increase in value is included in profit, and the period is greater than one year, the distribution of this total profit over this period and the determination of the annual rate earned may be done by one of three methods,

Simple interest based on initial investment.
Compound interest based on initial investment.
Simple interest based on average investment for the period.

By the first method, the sum representing profit is divided by the investment, and then by the years in the period.

Let $P =$ total profit
$n =$ period in years

Then $$x = \left(\frac{P}{I}\right)\frac{100}{n}$$

e. g. An investment of $5,000 earns $5,000 in 10 years.

Then $$\left(\frac{5000}{5000}\right)\frac{100}{10} = 10 \text{ per cent annually}$$

To adapt this formula to all conditions, let

$R =$ Net operating income
$V_v =$ Final value of property exclusive of this income.

Then: $$x = \left(\frac{R + V_v - I}{I}\right)\frac{100}{n}$$

If in the above case the profit is composed of $3,000 operating income and $2,000 appreciation of property value:

$$x = \frac{3000 + 7000 - 5000}{5000}\,\frac{100}{10} = 10 \text{ per cent annually.}$$

This method is seldom used, since deferred income must normally be discounted and is not the equivalent of annual income.

By employing discount values the rate obtained is one which would produce the profit at the end of the period but not before. This rate is found by the formula

$$1.0x^n = \frac{P + I}{I} \text{ and } x = 100\left(\sqrt[n]{\frac{P + I}{I}} - 1\right)$$

For all cases this becomes

$$1.0x^n = \frac{R + V_v}{I} \text{ and } x = 100\left(\sqrt[n]{\frac{R + V_v}{I}} - 1\right)$$

e. g. in the above example

$$1.0x^{10} = \frac{3000 + 7000}{5000} = 2$$

$$\log.\ 1.0x = \frac{\log.\ 2}{10} = .030103$$

$$x = 7.2 \text{ per cent annually compounded.}$$

When the property is appraised at its cost, or I

$$R = P \text{ and } 1.0x^n = \frac{R + I}{I}$$

The third method is an attempt to substitute for short periods a calculation which does not require logarithms. This is done by accepting simple interest or $\frac{P}{n}$ as the annual income, but assuming that it is added to the capital each year and that the average capital for the period, thus obtained, is the basis for the rate earned.

Let $V_n =$ Final or total capital including profit.

Then annual income $= \frac{V_n - I}{n}$

Average capital $= \frac{V_n + I}{2}$

$$x = 100\left(\frac{V_n - I}{n} \div \frac{V_n + I}{2}\right)$$

$$= \left(\frac{V_n - I}{V_n + I}\right)\frac{200}{n}$$

This is known as *Pressler's formula* for average periodic per cent earned; e. g. in the example given,

$$x = \left(\frac{10000 - 5000}{10000 + 5000}\right)\frac{200}{10} = 6\tfrac{2}{3} \text{ per cent}$$

The results by this method will coincide more closely with compound interest, the lower the rate earned. Its most common use is to determine the per cent earned on standing timber for a current period or decade.

These principles apply whether the rate sought is based on realized income or is merely an appraisal of future possible profits.

50. Ratio versus Rate of Profit. — In the above examples, the profit consisted in doubling the original investment. The ratio of

$$V_n : I = 2 : 1$$

The per cent of profit independent of the rate is

$$x = \left(\frac{P}{I}\right) 100 = 1 \times 100 \text{ or } 100 \text{ per cent}$$

Ratios of profit are usually expressed as inclusive of the original investment. The relation between the ratio of profit earned for a given period by deferred income and the corresponding rates of simple and compound interest becomes increasingly important with the length of the period involved.

For a given ratio of profit of 100 per cent or 2 : 1, the results are as follows:

Years required to double investment	Annual rate earned: Simple interest per cent	Annual rate earned: Compound interest per cent
1	100	100
2	50	41.4
5	20	14.8
10	10	7.2
20	5	3.5
50	2	1.4
100	1	.7

If on the other hand the investment increases twenty-fold, with $P = 19\ I$, and $V_n = 20\ I$, and ratio 20 : 1 the results are for

Years required in increase 20 fold	Annual rate earned: Simple interest per cent	Annual rate earned: Compound interest per cent	Relation of compound rate to rate of simple interest
5	380 ~~82.0~~	82.0 38.0	.22 .46
10	190 – ~~34.9~~	34.9 ~~19.0~~	.18 ~~.55~~
20	95 – ~~16.2~~	16.2 ~~9.5~~	.17 .59
50	38 – ~~6.2~~	6.2 ~~3.8~~	.16 .61
100	19 – ~~3.05~~	3.05 ~~1.9~~	.16 .62

For a rate of 2 : 1, the rate of compound interest lies between .80 and .70 of the rate for simple interest, but with a ratio of 50 : 1

the compound rate is but .20 to .16 of that for a simple interest. These relations have an important bearing on the entire problem of comparing profits on long term investments especially in forestry since they indicate that an annual rate of compound interest for such periods and ratios is not comparable with standards set by annual income and simple interest. The unreliability of these ordinary mathematical means of comparison is the cause of much confusion in the science of Forest Statics and leads to many erroneous conclusions.

51. Direct Appraisal of Rate of Annual Profit. — Appraisals of future profit are sometimes based directly on an estimated total rate of annual increase in values. In this case the rate is usually derived from charts or curves of past increases, assuming that they will continue at this rate. Simple interest is the most reliable basis for such predictions. Over any long period the annual rate of increase in value tends to fall, if based successively on the increased value of the capital. E. g., it is estimated that on the basis of present value, a tract of timber will increase annually, by growth, 3 per cent; by quality betterment, 2 per cent; by improvements in lumber prices, and by better methods of logging, 3 per cent; and that it will cost 1 per cent to carry the investment. The annual profit is:

$$1.0x = 1.0(3 + 2 + 3 - 1)$$

$x = 7$ per cent annual increase, or a doubling of value in 14 years. This equals about 5¼ per cent compound interest in that period.

52. Profit in Terms of Capital Values. — The process of determining capital values is the reverse of that required to find the rate earned annually. In this process it is the rate, instead of the initial investment or cost, that must be fixed as a preliminary to appraising the resultant value of the property. E. g.

$$\text{Value} = \frac{\text{net income}}{\text{ratio of compound interest}}$$

Profit, by this process, is shown not as a rate, but as the present cash value of the discounted future entrepreneur's gain.

Let $P_0 =$ capital value of the gain G.

Then $$P_0 = \frac{G}{1.0p^n}$$

E. g. A gain of $5,000 is made on an investment in land in 10 years. Based on 6 per cent interest rate, this gain is now worth

$$P_0 = \frac{5000}{1.06^{10}} = \frac{5000}{1.7908} = 2792.04$$

The profit, in sales based on capital value, is of course the margin of selling price over cost. The formula which applies to all cases is

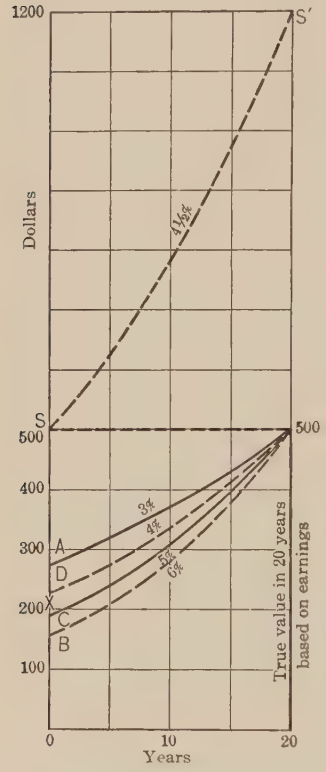
$$P_0 = \frac{R + V_v}{1.0p^n} - I$$

as illustrated in the above example where present appraised value is $7,792.04, and cost $5,000.

Such capital values are always appraisals, by individuals (§ 25), and are important as they guide or influence purchasers or vendors of property in endeavoring to agree upon a sale price. In this process the rate used is of first importance. E. g., if in the above case the rate used is 4 per cent, instead of 6, the appraisal gives a value of $3,377.92 for this profit. Lower discount rates indicate higher values for given profits, and vice versa.

When a buyer discounts expected profits his highest or limiting price will be set by using the lowest rate which he will consider as an adequate return. Any lesser price will enable him to earn a higher rate than this, or make a gain above this rate. An owner who wishes to sell property which will produce this income will fix his rock bottom price at a figure which would enable him to earn the same income as before, by investing the proceeds at a current or reasonable rate at interest. This is his discount rate and a sale at this price would safeguard this future income. The less he receives, the higher the discount rate which he has been forced to accept and the less his profit on the transaction. High discount thus favors the purchaser and low discount the seller. If both parties are well informed as to true values based on income, the spread between these prices will usually be divided, the market price falling somewhere between. If, instead, the buyer is deluded either by false ideas of possible income or by purely speculative desire to sell at a profit, the price soars above these limits as shown in Fig. V and the seller makes profits of a speculative or gambling character, whose rate based on cost may be excessively high. With each successive speculative turnover conditions become worse.

Development sometimes overtakes speculation. Where a solid basis of income exists, speculation merely retards development and diminishes the profits of the entrepreneur and pioneer by transferring them to the speculator through sales at high capitalized values.



A. Vendor's asking price based on 3 per cent.
B. Purchaser's bid based on 6 per cent.
C. Vendor's marginal price based on 5 per cent.
D. Purchaser's marginal price based on 4 per cent.
X. Possible market price based on 4½ per cent.
S. Speculative sale value not based on future earnings.
S'. Future value required to yield 4½ per cent.

FIG. V.—Determination of true vs. speculative market values.

It is not pretended that sales of land on the market are *actually concluded* by any such conscious process of mathematical appraisal. Income is too difficult to accurately appraise. When such income is deferred for long periods and is rendered uncertain by unknown future factors, the mathematical basis for an accurate computation of value is lacking. The price asked and the price bid for land is tremendously affected by *relative monopoly strength*, a

brisk demand for any purpose in a given locality immediately sending this price up regardless of appraisals of income possibilities. The ability to wait, or to buy in some other locality, is an indispensable requisite to a purchaser. Profits are so easily and quickly made in lands by *speculative turnovers,* and the determination of the value of actual operating profits is so much more difficult especially when interest formulae must be used as an aid, that much of the trading in land is *blind.* Eventually, false price levels will be corrected by the pressure of taxes and experience but not until much harm has been done. The holding of cutover stumpage lands at speculative prices not justified by any possible future income is a case in point.

CHAPTER VI

RENTALS

53. The Definition of Rentals. — In its simplest form (§ 52) the value of capital or property may be considered as derived from a single net return summing up the earnings over a definite period.

This summation of value fails to reveal the *true character of income* and its effect on value. It was shown (§ 32) that income is the measure of benefits from use that is distributed over and measured by a period of time.

Income is therefore a *flow whose rate* can be measured and valued. *A rental is a price* set on the use of a given property or capital for a definite *period of time.* An expense or annual cost acts as a negative rental.

Rentals are paid at stated intervals, between which the value of this payment accumulates or *accrues* and is included with the value of the property. When payments are due at monthly intervals, this accrued rental would have a correspondingly small effect on sale value, but an annual payment of interest appreciably affects it, the price of stocks being quoted as ex-dividend after such payment. The extreme case of accrued income is on forest soil planted to trees. On an even-aged plantation the accrued value of timber just before cutting may be many times greater than that of the soil which produced it. In any business, accrued rentals may be added to capital instead of being withdrawn, with the effect of increasing the amount of future earning power on the enlarged capitalization (§ 35).

54. The Summation of Rentals. — In Fig. VI the effect is shown upon the value of the property when the rental or income is realized at long intervals instead of monthly or annually.

When annual rentals are paid, the capitalized value $\frac{r}{.0p}$ in turn greatly exceeds the rental r, since the maximum change, if the rate p remains fixed, cannot exceed r.

A rental usually takes the form of a series of equal payments at definite intervals, as determined by the rate and period agreed

upon between contracting parties for the use of property. This represents the income received by the owner and paid by the lessor for the privileges of use.

The income earned by developing the uses of land in turn is relied upon to pay this rental. Thus the lessor, being the borrower, guarantees the rental and assumes the risk of earning it. In determining the possible rental which can be paid, the lessor

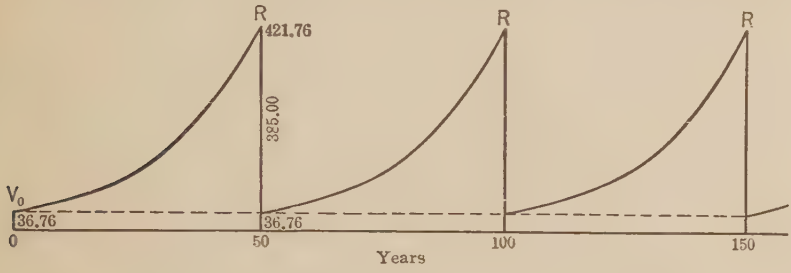


FIG. VI.—Relation of income to capital value for an even-aged stand or crop of timber.

Formula: $$V_0 = \frac{R}{1.0p^n - 1}$$

must appraise the earnings on the same basis, that is, as income part of which will go to the owner.

A still more important objective is to appraise the *value* of the property, which is always determined by the two factors, net income or rentals earned, and the rate demanded by investors, or the discount factor. For this purpose it is not sufficient to appraise the rental itself—the sum of values of all expected rentals must be found.

The process of finding the sum of these values is termed the *summation of rentals*. It consists of reducing the value which each rental has when paid to its equivalent in the year for which the sum is required, using the compound interest ratios as the measure of the difference. A rental of $1.00 payable 20 years in the future has a value now at 5 per cent discount of $\frac{1.00}{1.05^{20}}$ = 38 cents. The difference that time makes in the value of these successive rentals is brought out by exhibiting the value at the present moment of $1.00 if payable in:

	Value now
1 year	.95
10 years	.61
20 years	.38
50 years	.09
100 years	.01

If these five rentals constituted the total yield of a property, its present value would be the sum of their discounted values or $2.04.

In the same way, the total accumulating value of rentals which are not withdrawn (§ 48) but are kept at interest until a given year are found by adding this interest to each rental. E. g., a rental of $1.00 paid 20 years ago and deposited at 5 per cent is worth now $1.00 $(1.05^{20}) = \$2.65$. The value of different payments, if left untouched and interest is earned, is:

When deposited	Value now
1 year ago	$1.05
10 years ago	1.63
20 years ago	2.65
50 years ago	11.47
100 years ago	131.05

The total value at the 100th year for these five payments can be found as $147.85.

Since in each case but $5.00 was paid, it is seen that the present value of future rentals is always less than the sum of the amounts paid, while the reverse is true if these were past sums put at interest.

55. The Past versus the Future in Summation of Rentals. — The sum of a series of rentals at the end of a period, by adding compound interest is termed future value, while the sum of a discounted future series at present is termed present value. A better conception is to regard these summations as merely the values at the end of a period, and at its beginning, respectively, regardless of where the present moment is located with respect to the series.

Such summations are needed for the following determinations:

the appraisal of capital values	(§ 27)
the appraisal of cost values	(§ 23)
the appraisal of entrepreneur's gain	(§ 21)

In appraising capital values, the only elements which affect such values are those which lie in the future. Past costs and past income are equally negligible in the calculation and are ignored.*

It follows that the sum of values sought is the present or discounted value of the net income. If every item of future gross income and also of future cost are thus discounted and the net present value found, this result gives the capital value of the property.

When we come to consider the time *actually past,* the accumulation of rentals is strictly limited. It will apply only under one condition, that is, that the rental is actually not withdrawn, paid, or cancelled, but that the date of settlement is postponed and the reckoning not made until that date is reached, and that the basis of settlement is to be compound interest. In ordinary affairs this does not hold. Debts left unpaid are just as often settled without interest as with it, and if interest is included it is more apt to be simple than compound. There is an instinctive revulsion against permitting compound interest to run against debtors, as being an inhuman process, leading to peonage as it exists to-day in semi-civilized countries.

When, by contrast, an enterprise is deliberately undertaken which requires a period of years for its completion, the owner usually desires to compute his cost value by including interest. In this case, past costs plus interest may be treated as the sum of rentals at the end of the period. When this enterprise is brought to completion, the account is balanced and, whether it shows profit or loss, interest calculations terminate and a new account is started.

A resemblance to this process of summarizing past rentals is found in the process of dealing with future annual costs in a similar investment where income is postponed. These costs may be summarized for the final future year, and the deduction made from income in that year. This gives the entrepreneur's gain for that year. But this step in itself is valueless until the net income has been *discounted to the present* (see comparative discounted values for $1.00 above), and this present net value will be identical

* It must not be supposed that past costs or efforts have had no effect upon capital value. (§ 111) These costs on the contrary have made such value possible and largely determined its amount. But in *valuing* this property, the effects only are measured, as determined by the resultant prospects of future net income.

with that obtained if costs as well as income had been directly discounted in the first place. Hence, capital values are always the sum of the present discounted values of future positive and negative rentals, or income minus expense; as appraised at a given rate of interest.

56. General Formulae for Obtaining Sum of Rentals. — Rentals of equal value, payable at equal intervals and calculated to the present at compound interest or discount, form a series the terms of which are a geometrical progression, each term derived from the preceding one by a multiple. For the sum of past annual rentals, this multiple is 1 + rate of interest, or $1.0p$ (§ 34).

If an item r is received or is expended annually for 5 years, the value at the end of the fifth year, or the sum of these five payments with interest on each, if we assume that the payment is made or interest begins at the *end* of each year, is,

Final payment	r
Fourth payment	$r(1.0p)$
Third payment	$r(1.0p)^2$
Second payment	$r(1.0p)^3$
Initial payment	$r(1.0p)^4$

Let $R =$ sum of values at end of period.

$$R = r + r(1.0p) + r(1.0p)^2 + r(1.0p)^3 + r(1.0p)^4$$

This is an increasing geometric series whose ratio is $1.0p$. The exponent of the last term is 1 less than the number of terms, n, and can be expressed as $n - 1$. The series may be generalized for any number of years, n. Arranging the terms in the order of magnitude, beginning with the last, or this year's rental, each previous year's value being larger in the present year by one more year's accumulated interest, this series then becomes:

$$(1) \quad R = r + r(1.0p) + r(1.0p)^2 + r(1.0p)^3 + \ldots . r(1.0p)^{n-1}$$

To find the sum of such a series, the equation may be simplified by first multiplying it by $1.0p$, and from the resulting equation, (2), subtracting the original, (1).

$$(2) \quad R(1.0p) = r(1.0p) + r(1.0p)^2 + r(1.0p)^3 + \ldots . r(1.0p)^{n-1} + r(1.0p)^n$$

$$(1) \qquad R = r + r(1.0p) + r(1.0p)^2 + r(1.0p)^3 + \ldots . r(1.0p)^{n-1}$$

$$(3)\ R(1.0p) - R = r(1.0p)^n - r$$

$$R(1.0p - 1) = r(1.0p^n - 1)$$

$$R = \frac{r(1.0p^n - 1)}{1.0p - 1}$$

$$= \frac{r}{.0p}(1.0p^n - 1) \qquad (I)$$

E. g. A rental of $1.00 for 20 years at 5 per cent gives at the end of the period

$$\frac{1.00}{.05}(1.05^{20} - 1) = 20.00(2.6533 - 1) = 33.06$$

Rentals may terminate after a given number of payments, or they may be regarded as perpetual. They may be paid annually, or at longer or shorter intervals. If the interval is longer than one year the rental is termed intermittent. Formula I may be generalized to apply to any of these cases, and the generalized formula may be used to derive each of the others.

Let $S =$ sum of any geometric series.
$a =$ first term of series.
$q =$ ratio of multiple.
$n =$ number of terms.

Then $$S = \frac{a(q^n - 1)}{q - 1} \quad \text{(See I above)}$$

A descending series has for its ratio a value less than 1, e.g. $\frac{1}{1.0p}$ or $\frac{1}{1.0p^n}$. When the number of terms, n, is ∞ the value of the final term of the series is zero. To apply the above general formula conveniently to such a descending series representing future income or cost in order to obtain its capital value, both the numerator and denominator of the fraction may be multiplied by the factor -1.

$$S = \frac{a(-q^n + 1)}{-q + 1}$$

$$= \frac{a(1 - q^n)}{1 - q}$$

When zero is substituted for the value of the last term q^n:

$$S = \frac{a(1-0)}{1-q}$$

$$= \frac{a}{1-q}$$

57. **Specific Formulae for Sum of Rentals.** — *Future value of sum of rentals, R,* at termination of the series. Annual rentals, payable n times

$$R = \frac{r}{.0p}(1.0p^n - 1) \qquad (I)$$

Future value of intermittent rentals, payable n times at intervals of m years

Since the first term, $a = r$ and the ratio $q = 1.0p^m$

$$R = \frac{r(1.0p^{mn} - 1)}{1.0p^m - 1} \qquad (II)$$

e. g. A rental r of \$100 is payable 10 times (n) at intervals of 5 years (m)

$$R = \frac{100(1.05^{5\times 10} - 1)}{105^5 - 1} = \frac{100(10.4674)}{.2763}$$

$$= 3788.41$$

Present value of the sum of future or discounted rentals.

Let $V_0 =$ Capital value

Annual rentals, payable n times. The sum of "future" values in formula I may be discounted to the present by $\frac{1}{1.0p^n}$

Then
$$V_0 = \frac{r(1.0p^n - 1)}{.0p \times 1.0p^n} \qquad (III)$$

or by the general formula; the series is

$$V_0 = \frac{r}{1.0p} + \frac{r}{1.0p^2} + \frac{r}{1.0p^3} + \ldots\ldots \frac{r}{1.0p^n}$$

Then
$$a = \frac{r}{1.0p} \text{ and } q = \frac{1}{1.0p}$$

$$V_0 = \frac{\frac{r}{1.0p}\left(1 - \frac{1}{1.0p^n}\right)}{1 - \frac{1}{1.0p}}$$

which reduces to

$$V_0 = \frac{r(1.0p^n - 1)}{.0p(1.0p)^n}$$

e. g. A rental of $1.00 payable annually for 50 years beginning one year from to-day, is worth now at 5 per cent,

$$V_0 = \frac{1.00(1.05^{50} - 1)}{.05(1.05)^{50}}$$
$$= \frac{1.00}{.05} \times \frac{10.4674}{11.4674}$$
$$= 20.00(.9127) = 18.25$$

Intermittent rentals payable at the end of m *years for a total of* n *times.* The sum of "future" values in formula II may be discounted to the present by $\frac{1}{1.0p^{mn}}$

Then $$V_0 = \frac{r(1.0p^{mn} - 1)}{(1.0p^m - 1)1.0p^{mn}} \qquad \text{(IV)}$$

or by the general formula, the series is

$$V_0 = \frac{r}{1.0p^m} + \frac{r}{1.0p^{2m}} + \frac{r}{1.0p^{3m}} + \ldots\ldots \frac{r}{1.0p^{nm}}$$

Then $$a = \frac{r}{1.0p^m} \text{ and } q = \frac{1}{1.0p^m}$$

$$V_0 = \frac{\frac{r}{1.0p^m}\left(1 - \frac{1}{1.0p^{mn}}\right)}{1 - \frac{1}{1.0p^m}}$$

which reduces to formula IV

e. g. The value of $\frac{r(1.0p^{mn} - 1)}{1.0p^m - 1}$ from previous example II is $3788.41.

Then $$\frac{1}{1.0p^{mn}} = \frac{1}{1.05^{5\times 10}} = \frac{1}{11.4674} = .0872$$

$V_0 = \$3788.41 \times .0872 = \$330.34$, which equals the sum of the values of ten payments of $100.00 each at five-year intervals, discounted to the present.

Annual rentals, payable at the end of every year, forever.

$$V_0 = \frac{r}{1.0p} + \frac{r}{1.0p^2} + \frac{r}{1.0p^3} + \cdots\cdots \frac{r}{1.0p\infty}$$

Then $$a = \frac{r}{1.0p} \text{ and } q = \frac{1}{1.0p}$$

$$V_0 = \frac{\frac{r}{1.0p}}{1 - \frac{1}{1.0p}}$$

$$= \frac{r}{1.0p - 1}$$

$$= \frac{r}{.0p} \qquad \text{(V)}$$

e. g. A rental of $1.00 is due annually for a perpetual lease. At 5 per cent its value now is

$$\frac{1.00}{.05} = 20.00$$

Intermittent rentals, payable at the end of every n *years, forever:*

$$V_0 = \frac{r}{1.0p^n} + \frac{r}{1.0p^{2n}} + \frac{r}{1.0p^{3n}} + \cdots\cdots \frac{r}{1.0p\infty}$$

Then $$a = \frac{r}{1.0p^n} \text{ and } q = \frac{1}{1.0p^n}$$

$$V_0 = \frac{\frac{r}{1.0p^n}}{1 - \frac{1}{1.0p^n}}$$

which reduces to:

$$V_0 = \frac{r}{1.0p^n - 1} \qquad \text{(VI)}$$

e. g. A net rental or income of $100.00 per acre is received from a crop of timber every fifty years, without diminution of soil fertility. Its value in the first year, previous to planting, at 5 per cent is:

$$V_0 = \frac{100}{1.05^{50} - 1}$$

$$= \frac{100}{10.4674} = 100 \times .0955$$

$$= 9.55$$

Intermittent rentals payable first in m *years, and again every* n *years forever.*

$$V_0 = \frac{r}{1.0p^m} + \frac{r}{1.0p^{m+n}} + \frac{r}{1.0p^{m+2n}} + \cdots\cdots \frac{r}{1.0p\infty}$$

Then $$a = \frac{r}{1.0p^m} \text{ and } q = \frac{1}{1.0p^n}$$

$$V_0 = \frac{\frac{r}{1.0p^m}}{1 - \frac{1}{1.0p^n}}$$

$$V_0 = \frac{r(1.0p^{n-m})}{1.0p^n - 1} \qquad \text{(VII)}$$

If the term $n - a$ is substituted for m to represent the period subsequent to the last payment in the year a, this formula becomes

$$V_0 = \frac{r(1.0p)^a}{1.0p^n - 1} \qquad \text{(VII)}$$

e. g. The timber in the last example can be cut in 10 years, and again every 50 years.

Then $$V_0 = \frac{100(1.05^{50-10})}{1.05^{50} - 1}$$

$$= \frac{100(7.04)}{10.4674} = \$67.25 \text{ per acre.}$$

Intermittent rentals payable now, and again every n *years, forever.*

$$V_0 = r + \frac{r}{1.0p^n} + \frac{r}{1.0p^{2n}} + \cdots\cdots \frac{r}{1.0p\infty}$$

Then $$a = r \text{ and } q = \frac{1}{1.0p^n}$$

$$V_0 = \frac{r}{1 - \frac{1}{1.0p^n}}$$

$$V_0 = \frac{r(1.0p)^n}{1.0p^n - 1} \qquad \text{(VIII)}$$

e. g. In the above example the timber, worth $100.00 per acre, is about to be cut. Its value is:

$$V_0 = \frac{100(11.4674)}{10.4674}$$
$$= \$109.55 \text{ per acre}$$

Formula VIII may be expressed:

$$V_0 = r + \frac{r}{1.0p^n - 1}$$

by separating the first term and finding the sum of the remaining series from formula VI.

e. g. In this example the timber when cut is worth $100.00, leaving the residual value of $9.55 as that of the soil. This agrees with the value of the property as found in example under VI.

58. **Conversion of Intermittent into Annual Rentals.** — The capital value V_0 of any intermittent rental is converted into an annual rental by multiplying it by $.0p$ which represents the interest or rental on this capital.

When $n = 1$

$$\frac{R}{1.0p^n - 1} = \frac{r}{.0p}$$

and $$r = \left(\frac{R}{1.0p^n - 1}\right).0p$$

also $$\frac{R(1.0p)^{mn}}{1.0p^n - 1} = \frac{r}{.0p}$$

hence $$r = \frac{R(1.0p)^{mn}}{1.0p^n - 1} \times .0p$$

Any capital value, based on the interest rate p, can in theory be sold, and the resultant sum be placed at interest at this rate, yielding an annual income equivalent to the deferred and intermittent income from the other's investment. E. g. In formula III, the rental of $1.00 per year for 20 years, at 5 per cent, is equivalent to $18.25 × .05 = $.91 per year payable forever. In formula II the rental of $100.00 payable 10 times at 5 year intervals beginning 5 years from date is $330.34 × .05 = $16.50 per year. In formula VI the rental of land earning $100.00 every fifty years from a timber crop is, at 5 per cent, $9.55 × .05 = $0.47 per acre.

CHAPTER VII

FOREST RENT VERSUS SOIL RENT

59. The Effect of Rate Earned on Value. — The rate earned on an investment is the measure of its desirability (§ 42). This rate depends on net operating income or rentals yielded and on the purchase price paid. If this earned rate is considerably higher than the interest rate on borrowed capital, the market value of the property tends to increase, and vice versa. The constant tendency therefore is for the sale value of property to change in the direction of the value of net earnings capitalized on the basis of the interest rate. This increase or decrease in the market value of the property is a potential profit or loss from anticipated or expected net operating income and may be "taken" or credited by revaluing assets, or is actually realized if the property is sold at this value. Since the actual rate earned cannot be determined until it is realized, while capital value must always be appraised in advance of realized income, these values rest on current and past experience and expectations, and may finally prove to have been greater or less than was anticipated (§§ 52 and 70).

60. The Going Concern. — The earned income is in most desirable form when it can be harvested annually since this condition harmonizes most closely with the needs and desires of all investors. The less capital the investor has, the more necessary is this annual income, and the longer the period in which income is deferred, the less interested the average small investor becomes in such an undertaking.

No income can be earned from any enterprise until the latter can offer to purchasers a desired marketable commodity. To produce this commodity requires a period of time which cannot be decreased beyond a certain limit (§ 38).

The business process thus consists of continuously producing goods in such quantities and at such a rate that a fairly steady stream of products is available from month to month, or during each year, no matter how long it takes to produce them, whether a few days, six months, three years or half a century (§ 15).

Any enterprise which has built up its operation to the point where all the processes of production are proceeding simultaneously,

including the delivery of the final product and receipt of income from sales, is said to be a going concern. This is independent of which way it is going, whether up or down hill, for the latter depends not on the above facts but on whether it is making a profit or not from its operating income.

61. **The Formative Period.**—Any enterprise which has not yet reached this point is by contrast in the process of creating a going concern and requires and absorbs a constant stream of capital until it reaches that condition (§ 16).

To an enterprise which is just beginning, and which may take several years for completion, such as a transcontinental railroad, operating income is unavailable during this period of construction. Interest on the borrowed capital and even dividends on stock may be financed by further increases of capital pending the completion of this period of construction. Thus the final investment or cost value is not determined until operating income takes the place of capital contributions.

With most enterprises this transition or formative period is relatively brief and is rushed to completion as rapidly as possible by increasing the rate of construction. The division of the cost into fixed investments represented by land, buildings and equipment, and working capital represented by cash, accounts and bills receivable and inventories, is fairly clear; but the final capital employed by a going concern equals the total value of all the capital put into the business regardless of what it is used for, and the operating income should pay a return on all this capital annually, whether borrowed or not.

62. **Continuity of Income.**—On this capital employed, the business is managed so as to earn as large a rate of income annually as possible. There are two factors at work, one tending to stabilize this annual return, the other to disturb it. Stability within given limits produces larger net income by reducing expense, increasing efficiency especially of labor, and minimizing equipment costs. On the other hand, market prices vary with changing economic conditions so that expansion and contraction of output are necessary to market the product to best advantage and earn largest profits. By balancing these two tendencies a business plans to maintain a variable but continuous output commensurate with largest profits.

63. Creating a Going Concern in Forestry. — The business of forest production is the most extreme example of these tendencies. A forest is a going concern whenever and as long as it contains sufficient wood suitable for cutting and marketing, to bring in a net operating income annually. It is a profitable concern if this income is sufficient to pay a return on the capital employed. Whether this profit yields in turn an entrepreneur's gain is another matter, depending on the rate of interest expected and received.

It takes from 20 to 150 years to produce wood of desired forms and quality dependent on the product wanted and on the site and species producing it. This is the normal period for the absorption of capital, provided there is no forest to begin with! To create a forest as a going concern out of barren or totally deforested land means the facing of a period of construction, devoid of operating income, which, measured by other human enterprises, is excessively long.

Since no income is expected until this period is completed, the investors are out the interest on their money. If money is borrowed, this interest mounts up at an appalling pace, especially if the interest rate is high. If money is *not* borrowed, this calculation of interest is not actually an expense, and does not increase the capital investment, which is confined to the amount paid in or expended. It merely gauges the amount of postponed dividends by comparison with earnings possible in other fields which are paying an annual income.

Most forest areas originally were stocked with a stand of timber, not produced artificially by planting, but just as effectually furnishing the necessary capital to launch at once a going concern in forest production, in which all stages of growth or production are present. In the case of the forest, there is one process of primary importance, the establishment of a new crop of trees on cutover land. As the creative energy of growth set in motion by this process endures through the entire period, the secret of continuity in this business lies in initiating the process anew on different areas or different portions of the same area each year, so that there will be a succession of crops of the product available for the realization of operating income annually.

64. The Business Unit the Basis of Operating Income. — A business enterprise is a unit under one management and its oper-

ating income and profits are computed on the basis of this unit. Different steps in the process are not separated as distinct businesses unless there is an actual physical separation into two properties. Nor is a forest estate separated into different stands or age classes as a basis of determining operating income, any more when timber is being grown than when it is not, or when the only interest the owner has in it is to log it.

In any business, whether it be lumbering, forestry or manufacturing, net operating income in a going concern means the sum which remains after payment of all expenses for the year out of income for the year, including taxes on land, fire protection, and the cost of initiating and carrying along every process whose simultaneous conduct is necessary to produce this income continuously. So in forestry as a going concern the taxes on land, fire protection, cost of planting, and all expenses necessary to the initiating of a new crop of trees each year in place of those harvested, and to the growing, tending and improvement of each of the other successive previously initiated crops in the series, is a part of the annual expenses of conducting this business in order that the operating income may continue indefinitely.

65. Net Operating Income versus Liquidation of Capital Assets. — If a business does not provide for its own continuance, even to the extent of spending money on extensive research into new processes and methods, then that business is showing an operating income which in actual analysis it is not earning, and is in fact drawing on its capital or liquidating. The owners of forest lands stocked with virgin timber had the capital at hand to undertake permanent management as a going concern from the moment of beginning operations, but for the most part they did not have any intention of undertaking this business at all. The possibilities of such a business were not grasped nor the simplest of its requirements understood, namely, that of establishing the new crops to succeed the old. Hence they deliberately and continuously withdrew the forest capital until it was completely depleted and all possibility of managing it as a going concern was lost until a period elapsed equal to the time required for its restoration by the slow process of natural growth. Over a large per cent of this cutover area these operations even destroyed the capacity of the forest to reproduce itself to valuable species. These processes still continue.

The reason for this economic tragedy was that these owners were engaged in the business of logging and manufacturing the timber, not in growing it, but its effect is the same as sawing off a limb while sitting on it. With the exhaustion of the forest capital the limb supporting lumbering and the chain of industries dependent on it breaks and lets down the entire fabric of enterprise. There are many excuses and good economic reasons advanced for this neglect or refusal of private capital to undertake forest production but this will not interfere with the finally resulting crash.

66. **Annual Operating Income Versus Accumulating "Costs."** — When this process is completed, private enterprise, although viewing the stump prairies with alarm, faces obvious difficulties in undertaking forestry as a business. It will not be a going concern again for 50 or 60 years, and how about compound interest charges! Nothing less than 6 per cent is thought of, and it is easy to show, by merely adding the expected income of 6 per cent compounded for 100 years to the cash outlay, no matter how small, and calling it all cost, that the expense of growing timber is prohibitive; but on a similar basis no one could afford to hold virgin timber, pay the taxes on it, protect it from fire and wait for the market to reach it. Virgin timber held for speculation, that is, not operated, is the same kind of an investment as forest land ready for planting, and if the period of waiting were equally long it would prove to be much the less profitable an investment. There is no operating income with which to meet these taxes, and where is the interest coming from on the original cost, or on the present sale value if tied up in these forests? On a 6 per cent basis it has frequently been computed that stumpage values must double every 8 years or so (compound interest at this rate doubles in 12 years, and the taxes and protection and land investment speed it up) if the owner is to break even. This might be so, with non-operating speculative owners, who in spite of these assumptions would still make a very satisfactory profit if they sold on this basis; but it cannot even be assumed of a business with an operating income, or a going lumber business, which cancels the accumulating cash outlay annually out of sales, and declares annual dividends on the outstanding capital including that invested in stumpage. Compound interest does not accumulate,

in fact, against any portion of the capital of a going concern, whatever may be the theoretical assumption.

67. **Forest Rent.** — Forestry enterprises therefore resolve themselves into two classes; those which are able to secure sufficient wood capital to establish a going concern without undergoing a period of development awaiting the growth of the timber; and those which are not. The former enterprise is entirely independent of compound interest in determining costs of production. For such a concern the rate earned is put on an annual basis. The annual net income from such a forest is termed the *Forest Rent*. This income is manifestly the earnings of the entire forest capital, land, timber and improvements, taken as a single business enterprise on a basis identical with universal custom in business organization. Forest rent reaches its maximum when the sustained annual net operating income from such a forest unit has been built up to the highest possible sum. This is standardized for comparison with other forests by reducing it to annual net *income or rent per acre*. True forest rent is *actual net income*. Yields per acre obtained by depletion of forest capital are not comparable with rent. Maximum forest rent is secured by building up the forest capital to a high state of productiveness and by permitting the timber crop to grow to sizes which command high stumpage prices. It is the outstanding goal of public management.

The rate earned on invested capital by a given forest rent is a matter of minor public importance, since this depends upon the value placed upon the forest property. In public forests there is frequently no initial cost of land, and where land has been purchased the desire to show high rates of profit on such costs is subservient to public service. Where private enterprise is concerned, either the forest is purchased when already in the condition of a going concern, or else it takes some years to bring it into this condition. If the first supposition holds, the rate earned $x = \frac{\text{annual rent}}{\text{cost of purchase}}$. In the second case the owners are faced with the problem of adjusting their returns to their costs. Cash costs, if the period of development is long, total a much smaller sum than the property should cost if bought at the culmination of its organization when ripe for income. If the same

formula is used, $x = \frac{\text{annual rent}}{\text{cash costs}}$, the rate earned will exceed that in the first example, though the two forests are identical in value.

The difference in rate is compensation for deferred returns. As long as the value of the forest is carried as the cash investment preceding income, this high rate can continue to be earned indefinitely. What happens, however (§ 70), is either a sale or a revaluation of the forest, which takes up this excess rate or profit, and establishes a new rate on a new and higher capital value. This new rate will be the basic rate of interest applicable to forests as going concerns in this region.

68. Soil Rent. — By contrast with the going enterprise all forests still in the formative or constructive state, whose income is postponed to some future period, are forced to compute the probable rate of earnings on the basis of compound interest on cash investments covering this period, or by some modification of this method (§ 49). After the forest has become established, this is no longer necessary.

The so-called *Soil Rent* theory is based upon this condition of deferred income and applies as an actual business condition only to such uncompleted enterprises. The theory is that the soil constitutes the true capital, and that the timber is income accruing until harvested when it represents the total income earned by the soil. The rate earned is of necessity determined by the value or cost of the soil as the investment and the entire period required to grow a crop of timber from seed as the span of deferred returns.

In application by its advocates, it is not this rate earned which interests them, but rather the capital value of the soil, obtained by crystallizing an arbitrary basic rate of interest for forestry (§ 80), and on this rate proceeding to capitalize the net income back over the rotation to the year just previous to establishing the crop. The appraised value of soil thus obtained (§ 95) is then multiplied by the rate of interest .0*p* and the product is termed *Soil Rent.* This is the annual equivalent of the final net value of the *crop rental* always regarded as postponed for the full period, thus having its *minimum present value.* (Fig. VI, page 61.) It is regarded as the annual income which the bare soil actually earns, and serves to compare the value of different soils for forest production.

The mistakes made by soil rent advocates lie not in the correctness of their premises, but in their attempt to *apply them to all forests regardless of age or condition.* There is but one condition to which soil rent can have any practical application, and that is to bare soil previous to planting or establishment of seedlings. There is but one class of forest property for which this condition holds good, and that is where a forest is absolutely non-existent, and the land is merely potential forest land. Hence technically it cannot apply to any existing forest property whatever (§ 1). Its real use is not in determining actual probable rates earned or capital values of forests, but as a basis for studies of *unit costs of production* or cost values (§ 89) on the one hand and as an aid in *appraising purchase values* for bare soils, on the other (§ 95). This requires a separate analysis of the value of unit parts without respect to the entire estate.

In applying the soil rent conditions as the basis on which all forests should be managed, this premise would substitute the single even-aged stand in the year of planting for the entire forest unit in its existing condition of development. Such substitution is impossible in business practice. The condition pre-supposed of a non-existent forest is the least desirable of all possible cases. As a forest approaches the form of a going enterprise it becomes more valuable and its prospective annual income is appraised at a continually higher figure. When it reaches this stage it can be maintained permanently on this level of value and income. Forests composed of mixed age classes, and possessing a high value on this basis may still show a negative or minus value for bare soil, which merely indicates that it does not pay to destroy such a forest and have to start building it up again from nothing. Forests not managed as even-aged stands possess no determined separate soil values.

The application of such soil rent determinations has been to try to indicate the age at which timber should be cut, by making it coincide with the period which showed the greatest discounted soil values or rent. Whether or not justified at the outset, for non-existent stands about to be created, it results if applied to established forests in an actual loss of profits from premature cutting and over-cutting, and reduces the forest rent yielded by such a property to a lower level than the maximum. Since this tendency to premature realization of income coincides with the

prevalent desire of private owners for income, especially where they are forced to build up a forest property, it also coincides with the fact that private forests in all countries are more poorly stocked as a rule and less productive than public forests. Applying standards based on deferred income as a permanent goal for a going concern will not work in forestry any better than it would in any other line of industry, and when such a forest becomes established it should no longer be governed by comparisons which have ceased to apply. The universal tendency in public forest management in Europe is towards longer crop periods in an effort to attain the maximum *forest rent* or greatest productiveness, regardless of compound interest on past costs of establishment.

CHAPTER VIII

THE RATE OF INTEREST AND THE ENTREPRENEUR'S GAIN

69. Interest Rate as a Commodity Price for Capital. — The outstanding feature of a business enterprise is its employment of and need for capital to finance the business process, including wages, and to bridge over the time barrier between outlay and resulting income (§ 13-16). Money as an institution permits of the circulation and use of capital as a commodity independent of the capital assets or wealth on which its value largely depends, and which it represents. The owners of enterprises not only often lack the needed money or working capital to swing them, but they frequently find it advantageous to borrow a part of the fixed capital investment as well, rather than to confine their operations to their own capital (§ 19-20).

Owners of capital, on the other hand, frequently prefer not to risk losses by launching business enterprises, and would rather let their money earn what it will at interest under the usual guarantees of a safe return of the principal. Capital thus becomes a commodity, the use of which is bought and sold.

The price of this commodity, money capital, is the rate of interest. Being a price, the interest rate does not remain stable but is constantly changing. The price of interest rises or falls in response to forces similar to those which cause prices of any other commodity to change.

In periods of prosperity, when the ratio of earnings to invested capital increases in the form of greater profits, the demand for capital also increases. This requires an increase in the supply of liquid capital over and above what is at the time available or in use or out at interest. Since profits in business are good, money will not be withdrawn from such enterprises to be loaned, instead, at the prevailing rates of interest; but if this rate advances, the increase will have a double effect. It will cause a certain number of entrepreneurs to abandon their business because of increased cost of borrowing and lessened consequent gain, and to pass over into the lender class to take advantage of this higher rate; and it will

induce a certain number of persons who otherwise would spend their money, to save and invest it instead. In final analysis, capital is accumulated by saving instead of spending it, that is by abstinence. An increase in the capital saved and hence available for loans comes from the marginal capitalist who having but small means requires the highest or marginal price of capital to make the difference between his spending or saving it. This law is illustrated in Fig. III, page 30. When, due to a change in economic conditions, the demand for capital slackens, borrowers will be able to get what capital they need from those who do not require this highest rate, and the marginal capitalist then ceases to lend his money, his marginal place being taken by one who will lend for somewhat less.

The general trend of the interest price is upward in time of war and downward in the eras of peace.

70. Interest Rate as a Regulator of Enterprise. — Interest is the most important of all prices since it permits the employment of capital and compensation for its use and hence makes possible all coöperative business enterprise dependent on time for consummation. It has a second equally important function in that it acts as an automatic regulator of human enterprise, guiding it always towards the goal of satisfaction of the most urgent needs with the greatest efficiency. The mechanism of this process is very simple and is explained by the two fundamental regulators of the relations of capital and income, already described; first, the rate earned on an investment, and second, the value of a given prospective investment at a fixed rate. The way this operates is as follows: A certain class of enterprise under certain conditions earns profits exceeding the average rate of interest. In new enterprises these profits may be excessive for a time. There is an immediate attraction of capital to this business, because of the higher reward. The result is, that not only do new competitive units spring up, but the owners of already established enterprises find it easy to capitalize their earnings at a rate much lower than the rate they are earning, and thus admit large quantities of additional capital into these industries, taking their own profits in this form (§ 52). The rate of earnings drops from both these sources until the marginal producers are squeezed out and the business stabilized, forcing surplus capital in turn to seek other fields of outlet.

71. **Factors Affecting the Interest Rate.** — The elements determining this movement and price of capital are the desire for profit, and the division of risks. Although as shown (§ 19) the lender seeks to transfer practically all the risk to the borrower, who as compensation for this burden takes all excess earnings, yet an *element of risk* remains attached to the loan and the character of this risk affects the price of the interest, so that in the case of insecure collateral the rate may be excessive. In theory this increased rate is intended to replace possible losses of capital, and the basic rate is for securities on which the guarantee is adequate, such as U. S. Government bonds.

Cost of re-investment is another factor, which causes short time loans to command higher prices than long time securities.

Prices of interest differ for *different forms of loans.* Mortgages fluctuate at least two per cent on first mortgage security, and much more than this on second mortgage. Commercial bonds pay from two to four per cent higher interest than public securities. Interest paid on savings bank deposits is nearly the basic rate. Federal loans on farm mortgages have greatly reduced the interest rates on this security. *The general level of the interest rate* is merely a rough basis or expression of the general state of the supply and demand for capital. This price will be modified up or down, for every separate class of risk, for each kind of business security, and especially, by the relative need or monopoly strength of the borrower, and of the industry for additional capital. There is no such thing as a fixed rate of interest, for any period or purpose, and to attempt to decide upon such a rate even for any particular class of enterprise or any given set of conditions, and then adhere to this rate, is to try to upset the economic basis of price.

72. **Factors Determining the Entrepreneur's Gain.** — In theory, all industry is guided, and the flow of capital determined, by the principle of the *entrepreneur's gain.* But on analysis this generality *must be qualified.* The characteristic of the entrepreneur is that he assumes risks in proportion to the profits he expects. The greater the anticipated profit the larger the risk. Profits are greatest in new fields because these enterprises are uncharted, and capital is timid. If the venture proves successful, the entrepreneur reaps his hoped-for gain by the very fact that capital now seeks this field, and raises the value of the assets by

lowering the average expected rate to be earned, through competition for opportunity.

The overcoming of risks in a new business requires concentrated attention and a high class of service. Failures are numerous. The loss not only of profits but of capital in new ventures or speculative enterprises, such as oil development, is so great that it is stated that the average profits earned by all industries is less than the normal rate of interest on loans and that by and large the *entrepreneur's gain is non-existent for industry as a whole,* and the only reward for capital is in the form of interest as earned by industry.

In certain great industries such as farming this is especially true. For agriculture as a whole it is computed that the return on the capital investment is not over 2 per cent annually. The clearing and stumping of land in pioneer regions has usually been so unprofitable that it is a common saying that it takes three successive settlers to establish a going farm in a wooded region. The capital of such pioneers is expended without return.

Inseparable from this problem of the rate of interest is that of the *capital value of productive land.* The values of land in the more fertile agricultural regions of this country have constantly increased, and the difference in value between good and poor land has widened. The rate of profit on farms is dependent not on the value of the income, but as usual on the ratio used in capitalizing this income in sales, or

$$\frac{\text{Income}}{\text{Rate expected}} = \text{Sale Value.}$$

E. g. A farm producing an average net annual income of $1,000 would if capitalized at 5 per cent be worth $\frac{1000}{.05} = \$20{,}000$, but if this same income is capitalized at 2½ per cent the farm is valued at $40,000. If, as stated, farming is now on a 2 per cent basis, it means but one thing, that 2 per cent is the actual *rate of discount used* in establishing these sale prices, and that purchasers have been found in sufficient numbers to set the market value of farms at this level. With less speculation in land and less stimulation of land prices, farmers with the same income could obviously earn 4 to 6 per cent on land valued at one-half or one-third of the present prices. Farm rents are set by farm values. Here is a case

where the entrepreneur's gain has more than disappeared, *having been appropriated in the form of sales.* It cannot now be secured by an entrepreneur who takes up farming on the basis of these capital values.

In forestry, the opportunity for the entrepreneur to make a fair profit depends, as in farming, to a very great extent on whether the land can be *purchased or acquired at a price* which is less than that indicated by a proper or fair rate of interest on such an investment. Where, as in cutover regions, efforts were made to sell this land at speculative prices for agriculture, neither the prospective settler, much less the forester, could ever hope to realize profits from attempted development on this price basis. Where after years of futile effort to realize such profits from a false sale basis, such prices have collapsed and land become practically valueless on the basis of future agricultural development, the opportunity for entrepreneur's gain from forestry arises.

73. Entrepreneur's Gain in Forestry. — Large profits will be a temporary or passing phenomenon in forestry just as in any other line of industry. Speculative profits are a lure, eagerly pursued, resulting in good if sought by the true entrepreneur out of income, and in evil if sought solely through capitalizing the efforts of others in advance; attained most often through the private exploitation of stored-up natural resources in land which increase in value by reason of community development, and leading to a mad scramble for individual possession of such resources and the most wasteful sort of use.

The entrepreneur's gain which may be obtained through developing forestry on abandoned farms or cutover forest land possesses the same temporary character, in that a demonstrated high rate of profits will immediately raise the price of such lands and again reduce this rate to all new investors. What the final rate of interest will be in forestry will then be determined by such new prices for property, and not at all by the original relation of values to income. As in the case of farm lands, this process tends to wipe out the entrepreneur's gain.

This equilibration of capital and income is not a mere oscillation back and forth. The activities of the entrepreneur result in the creation of vast new wealth, which represents profit to the originators of this wealth, and prosperity to all dependent on it. The notable

example of the Landes district in France can be duplicated in kind everywhere that forestry is practiced. It took several decades of public experimentation, example, and remedial tax legislation to encourage private capital to undertake reforestation in this district. The land was worth a few cents an acre. After the reluctance of investors had been overcome, the industry rapidly developed. Profits of 5 and 6 per cent compound interest were realized. At the present time no such profits would be possible, since the property, even bare land, can no longer be bought for attractive prices. The rate of interest has crystallized at 2½ to 3 per cent, compounded. But where before the region was pauperized it is now the most prosperous in France.

74. Interest Rates on Loans in Forest Enterprises.—Rates of interest fluctuate most violently where there is urgent temporary need for money to finance current transactions, as illustrated by the rates for call money on stock exchanges. Rates of interest are of least importance in enterprises of long duration which are customarily financed not by borrowing but by owner's capital. Of these enterprises, forestry is the outstanding example. The argument that forestry cannot be practiced unless it yields a rate of interest in excess of that commanded by money borrowed in the course of financing various forms of industry of entirely different character, falls of its own weight. If there is need for borrowing money in the business of forestry, the character of the borrower and terms of payment will be of more importance than the relation of the loan to the profits of the business. As a matter of fact, the flotation of bonds for land purchased by states like New York or Pennsylvania constitute an investment in public benefits rather than profits, while private land owners have so far borrowed largely in connection with the logging and manufacturing business and not for timber production. No prices based on loans have as yet been established or quoted for the interest rate on money borrowed to finance the establishment of a forestry enterprise such as a plantation, and the nearest approach is to endeavor to find investments as nearly similar as possible and gauge the rate on that basis.

75. Rates Earned as a Basis of Investment in Forest Enterprises. — In considering the rate of interest which forestry should earn to make it attractive to private investors, its demands on the

investor must be considered. Efficiency and consequent rate of profit require attention and skilful direction, which means mental energy. Keenly competitive forms of industry exact a large toll of energy and a correspondingly great risk of capital. In forestry, successful practice requires equal intelligence and vigilance, but not such constant or close supervision. An illustration of this difference is seen in the farm woodlots. Any line of agricultural production requires operations timed to coincide with exacting natural requirements; but except for the planting of trees, and emergency fire-fighting, forestry work in the woodlot can be done whenever convenient, and may even be postponed one or more years without undue loss. The marketing of the crop is equally elastic, and to put off marketing it usually means an increase in its value through growth.

The value of margins as a factor of success in industry is well understood. The use of slack time, the employment of labor in off seasons, the utilization of capital in dull times, the ability to turn to a stored-up source of income to tide over a bad situation, often makes the difference between profit and loss. It is stated that the woodlot in many hill towns of Connecticut makes the difference between success and failure in agriculture! The capital invested in forestry is earning its own income by the steady operation of natural forces. Some economists in the lumber industry have even gone so far as to claim that these forces do not even need skilled guidance, but that with a minimum of care in such essentials as fire protection the new wealth in cutover lands will develop without further supervision!

What the woodlot is to the farmer so is the greater problem of forest production to industry and capital in general. It can be made to form the *reserve of industry,* and the type of investment for capital which does not seek loans or interest, nor even entrepreneur's gains, or stock in enterprises controlled by other entrepreneurs, but which desires ownership of an enterprise that can be managed by the owner, will not demand too great a share of his attention and can be arranged to suit his convenience, and that in addition, has the satisfaction attached to land ownership, including the fishing and hunting or other accessories. The rate of income which should attract capital to such investments does not compare with that on commercial loans on any fair basis. On

such investments the entrepreneur's gain is not a deciding factor, its place being taken by other considerations.

76. The Law of Diminishing Returns versus Compound Interest. — The most common fallacy appearing in discussions notably in lumber trade journals on this question of possible profits and relative cost in forest production is not the adoption of a 6 per cent interest rate as the gauge of profit, but the assumption that compound interest at 6 per cent over long periods is the exact economic and mathematical equivalent of simple interest at that rate paid currently on loans.

Business must be conducted, it is true, on mathematical principles, but it is not confined to mathematics,—otherwise the bookkeeper would be the manager. Economic laws and physical laws are equally potent as business factors. One of the most fundamental laws of all enterprise and of life itself is that of diminishing returns. This is the effect of the influence of a limiting factor which bounds the expansion of any enterprise. This limiting factor is space or room, which is the element neglected by mathematicians who assume that in compound increase time is the only limiting factor.

An industry or a species of animal or plant life, if it finds what amounts to a vacuum, begins an expansion at a rate limited only by its inherent capacity or the rate of interest that applies to it. The beginning of such a curve corresponds almost exactly to a geometric ratio whose multiple is 1 plus this rate, or $1.0p$; but its continuance even for a brief period requires not only the continuance but the constant expansion of the vacuum at an equal rate, which never happens. Just as the extent of the available food supply would ultimately check the mutiplication of rabbits, even in the absence of enemies and of disease, so in business a compound rate of increase can be maintained only so long as no competition arises, every dollar of gain is reinvested hence no dividends are declared and no income withdrawn, and the market for the product expands as fast as the rate of increase in production, which is to set aside every known economic and physical law of business in a vain effort to prove that the accuracy of a mathematical formula is the correct interpretation of these business laws (§ 35). On the other hand, simple interest, which does not involve the indefinite expansion of the enterprise and which does

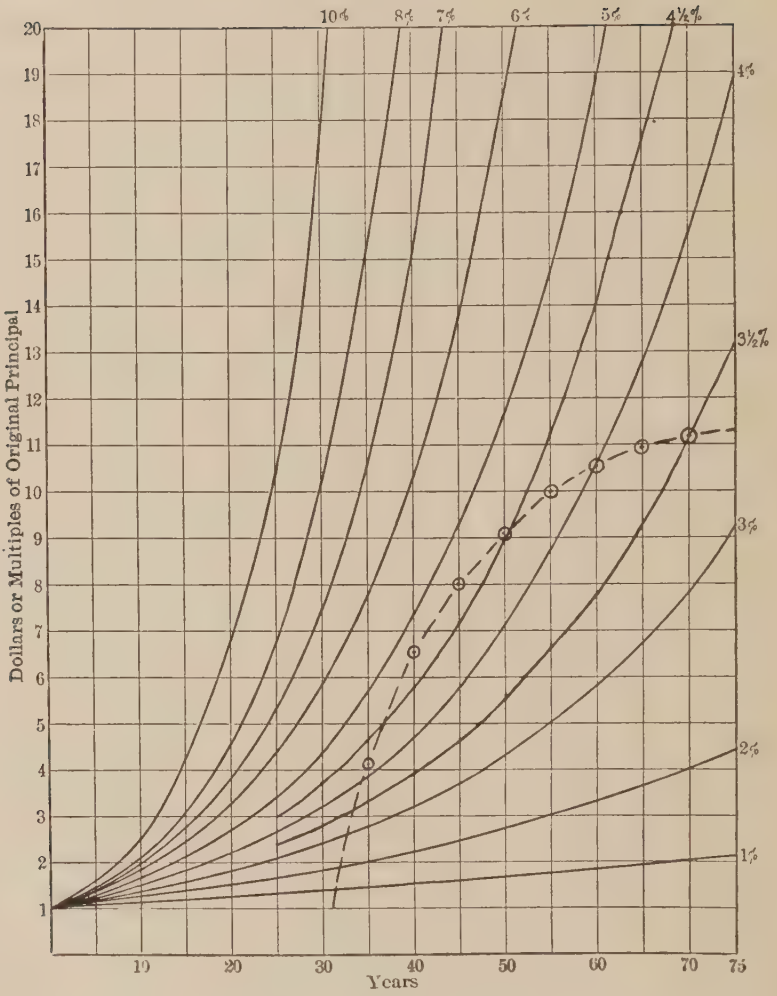


FIG. VII.—Rates at which $1.00 increases, at different rates of compound interest.* The line--⊙-⊙- represents the per cents earned by a white pine plantation at different ages, taken from Fig. X, page 151, and plotted in proper relation to the curves of compound interest. Based on $5.00 land value.

---

* A rate of 10 per cent, compounded, multiplies 20 times in 31 years. A rate of 1 per cent, compounded, doubles in 70 years. Even 6 per cent would, in 70 years, multiply the principal 59 times.

permit of withdrawing dividends annually, may because of these conditions permit of the continuance of a fairly high annual rate of income for a long period.

The factor that is overlooked is the tremendous increase in capital which is the requisite of an uninterrupted accumulation at a given rate of compound interest if extended over a long period. If in the form of wood laid on, the impossibility of the forest continuing indefinitely to grow at this rate is at once evident. Whether or not this accumulation is regarded as income, it most certainly is capital, and with this expansion, the ability to continue the same rate of increase becomes less and less because of the limiting factor of opportunity, or space.

77. **Compound Interest on Money Capital versus the Rate of Interest.** — In an effort to refute this irresistible law of diminishing interest rates, the sole argument is based on the mathematical possibility of obtaining compound interest by *re-investing money at a given rate.* This premise is fallacious. The price of money is if anything more sensitive than any other form of prices. Compound interest requires total abstinence, literally suspension of living as far as that individual concerned is dependent on the capital involved. There might be found an occasional investor who would permit a portion of his money capital to accumulate in this way for a time, but hardly for 40 to 50 years. Let even a small percentage of capitalists practice such complete abstinence and continually seek to secure 6 per cent on loans and the supply of *capital seeking interest* would at once tend to increase at the expense of the *residual capital directly engaged in production and risk taking,* on which the earning of this safe interest depends. The price of interest would fall and from this cause alone the rate of compound interest would drop in accord with universal economic law. A mathematical formula which applies only to the exceptional individual and only then in case the majority of others pursue a contrary and hence balancing course, does not establish the validity of the economic equality between 6 per cent simple and the same rate of compound interest.

78. **The Ratio of Profit versus the Rate of Compound Interest.** —This essential difference between simple and compound interest is further brought out by comparing the direct ratio between the initial investments and the final accumulated capital (§ 50).

TABLE I

COMPARISON OF PROFITS AND COMPOUND INTEREST ON AN INVESTMENT OF 1.00 AT THE END OF A PERIOD OF 50 YEARS

Rate of compound interest earned per cent	Equivalent rate of simple interest per cent	Ratio of profit to initial capital
1	1.28	.64
2	3.38	1.69
3	6.76	3.38
4	12.20	6.10
5	20.92	10.46
6	34.84	17.42
7	56.92	28.46
8	91.80	45.90
10	232.78	116.39

The figures in the second column indicate that to earn the rate of compound interest designated, an investment in 50 years must increase so rapidly that for 7 per cent compound interest the equivalent rate of simple interest on the initial capital would be 57 per cent and at the end of the period the capital must have increased more than 28½ times.

It is this rapid increase in absolute wealth which constitutes the specific attractiveness of investments paying only a moderate rate of compounded interest, provided the principal is reasonably safe from loss meanwhile.

79. Entrepreneur's Gain Expressed as a Margin of Rate Earned over the Rate of Interest. — As a final point in showing the impossibility of mathematical comparison between rates of simple interest and the same rate compounded, the assumption that a difference in per cent between the rate earned and the rate of interest assumed enables one to accurately compare the rates of entrepreneur's gain, can be shown to be in error. The difference between 4 and 6 per cent of simple interest is 2 per cent, but the difference between 4 and 6 per cent compound interest is equivalent to considerably more than 2 per cent compound interest.

In theory, the rate of entrepreneur's gain can be quite simply expressed as $x - p$ per cent (§ 49). This will hold good for simple interest and annual profit.

The rate x may also be determined by compound interest (§ 37), but the difference between x and p in the expressions $1.0x^n$ and $1.0p^n$ is no longer equivalent to that of $x - p$, but varies with each value of x, p, and n, increasing with the period n, and with the difference $x - p$.

TABLE II

EQUIVALENTS OF 1 PER CENT COMPOUND INTEREST WHEN THE FOLLOWING RATES ARE USED

Years	For 3% Rate at 1%	For 3% Excess	For 4% Rate at 1%	For 4% Excess	For 5% Rate at 1%	For 5% Excess	For 6% Rate at 1%	For 6% Excess
30	4.1	1.1	6.5	2.5	9.6	4.6	13.6	7.6
50	5.2	2.2	9.5	5.5	16.2	11.2	27.0	21.0
70	6.9	3.9	14.5	10.5	29.2	24.2	57.7	51.7

EQUIVALENTS OF 1 PER CENT ADDITIONAL, REPRESENTING ENTREPRENEUR'S GAIN, WHEN THE FOLLOWING RATES ARE USED

Years	For 3% Rate at 1%	For 3% Excess	For 4% Rate at 1%	For 4% Excess	For 5% Rate at 1%	For 5% Excess	For 6% Rate at 1%	For 6% Excess
30	2.3	1.3	3.1	2.1	4.1	3.1	5.4	4.4
50	4.2	3.2	6.8	5.8	10.8	9.8	17.1	16.1
70	7.6	6.6	14.8	13.8	28.5	27.5	54.5	53.5

In deriving the values in table II the value of 1 per cent compounded for the indicated period of years was multiplied by 3 as the equivalent of 3 per cent, and this total compared with the actual value of 3 per cent compounded. The first column gives the equivalent of 3 per cent expressed in terms of 1 per cent, e. g., 3 per cent for 30 years is equivalent to 4.1 times 1 per cent for the same period, indicating that the latter value is in excess of the former by the equivalent of 1.1 per cent. This same comparison is then made in the second half of the table to show the true weight of 1 per cent of entrepreneur's gain when added to different per cents of compound interest. The tremendous discrepancies which occur as the rates increase are significant. E. g., One per cent compounded for 50 years on $1.00 equals $1.64 or a profit of $.64. Three per cent gives $4.38 or a profit of $3.38. This profit is 5.2 times the earnings of a 1 per cent rate instead of 3 times this profit, as it would be if the difference were in the same ratio as simple interest. In the same way, it can be shown that if the entrepreneur's gain is 4 — 3 per cent, the additional 1 per cent earned is not $.64 but the difference between $6.11 and $3.38, which is $2.73, and when divided by $.64 or a 1 per cent profit, gives 4.2 times this profit, while 5 — 4 per cent gives $10.47 — 6.11 = $4.36, equivalent when divided by $.64 to 6.8 times 1 per cent instead of the 1 per cent indicated by this mere difference in the rates. In the above table the relative values of different

per cents earned are shown for 30, 50 and 70 years, by dividing the sum earned at from 3 to 6 per cent by the earnings at 1 per cent compound interest. In the second portion of the table an entrepreneur's gain of 1 per cent compound interest over and above 3 to 6 per cent respectively is likewise divided by the value of 1 per cent at compound interest, for 30, 50 and 70 years, and the multiple of this actually earned by the addition of 1 per cent to these higher rates is indicated, with the excess earned over a 1 per cent rate.

This table indicates that an entrepreneur who makes a rate of gain of 1 per cent higher than p per cent, when this rate is at compound interest, may be making anywhere from 2 to over 50 times the gain that is represented by a compound interest rate of 1 per cent, and that this discrepancy increases in a geometric ratio as the rate of interest and length of period increases. Hence, it is impossible to express the equivalent of $x - p$ per cent of simple interest when the compound interest ratios are used, and the true profits are greatly in excess of those so indicated.

80. The Basic Rate of Interest in Forestry. — Since future forestry must be carried on in a large part by private capital, or not at all, the activity of private enterprise in this field will continue to be influenced profoundly by current opinion regarding the rates which investors desire to earn on their capital in other enterprises of an entirely dissimilar character. The deterrents of private investment in forestry by comparison are:

the necessity for reëstablishing a going concern,
the abnormally long period which this process requires,
the almost complete ignorance of the character of the profits expressed by different rates of compound interest,
the consequent lack of an intelligible superficial basis of comparison of profit with enterprises earning simple interest,
the preference for immediate entrepreneur's gain rather than large increase in wealth which is postponed and based on abstinence, and
the failure to appreciate the specific advantages of a forest investment as supplementary to more active enterprises.

The conception of the basic rate of interest, p, is not confined to mere interest rates on borrowed capital. It is also (§ 21) the rate which the average investor will accept as a basis of *capital value* or purchase price at which he will undertake an enterprise,

and which tends to diminish his entrepreneur's gain. It thus becomes the *basic rate which he hopes to earn.*

The determination of fair basic rates which *can be expected* from forest investments is an absolutely necessary step for the guidance of investors, and such rates must be fully explained, not by an inadequate mathematical comparison, but on the basis of *ratio* of increase on investment. The basic rates, expressed in compound interest, must steadily decrease from the equivalent in simple interest, as the period of deferred returns lengthens. At the same time the *ratio* of returns as steadily increases.

Since individual private interest diminishes as the period of deferred returns increases, the most attractive private forest investments will continue to be those promising immediate returns or income within a short period, i. e. forests stocked with mature or partly mature trees. The less this period of waiting, the less the difficulty of comparing the returns with more familiar investments. Those undertaking plantations or reëstablishment of forests must and will base their enterprise on a sound understanding of the character of the investment and of the time and amount of the expected returns, and will not be deterred by false comparisons with current industrial enterprises.

The basic rate of compound interest to be used in capitalizing forest values or in indicating earnings must therefore be made to depend primarily on the *length of the period involved.* The rates which can be earned by forest investments covering such periods must *serve as a guide,* as to the fair rate for capitalizing values (§ 75).

When the risks incident to pioneer and unsettled status of forest property and enterprise are diminished to normal conditions, such enterprises present a degree of security from economic loss which is much greater than that of most other investments. For this reason the standard usually adopted in lieu of a better is the *rate paid by government securities* in times of peace or stability. It is certain that under stable conditions no higher rate should apply, because the comparison here as usual is between simple and compound interest. Where conditions are unstable, due to fires, taxes and lack of experience and example, investors as a purely business proposition are justified in seeking higher rates because under such conditions the risk, and consequent need for a margin for gain, is high; but this increased rate must still take

into account the essential differences between simple and compound interest above noted.

The fear of loss and the reluctance to accept a deferred return constitute an obstacle to private forestry so great and far reaching that it is the one outstanding explanation for the appalling extent of forest destruction and neglect on private lands. Confidence in private forestry as a business proposition can be created only through the united efforts of all agencies working for the establishment of forestry, among the most important of which is public ownership and example.

Entrepreneur's gains in the United States in the past have logically been sought almost exclusively in the purchase of timber already mature or nearly so. The element of profit depended on its price increment, due to growing scarcity of timber, and to the operation of the law of marginal values (§ 30). In such investments, purchasers have frequently overlooked the time cost and the carrying charges on capital *which does not earn annual income* with which to meet these costs (§ 33). *Growth* provides a means of meeting time costs, both actual (expense) and potential (interest), hence it can easily be demonstrated that investments in which not only price increment occurs but also increment in quality and in growth or absolute volume are far more promising than those dependent on price alone, except where price increment is strongly augmented by the growing scarcity of stumpage of high quality. One instance has been cited in Michigan where young pine timber purchased 40 years ago for $2.50 per acre is now valued at $1,020 per acre, a ratio of increase of 408:1. When private investors learn to properly appraise forest investments in terms of the creation of wealth as a source of profit, a very large field of new opportunities will open up for the investment of capital in the industry of forest production, and this will be accompanied by a new and saner outlook on investment, and one more conducive to the permanence of our institutions.

CHAPTER IX

COST VALUES OF FOREST PROPERTY

81. Characteristics of Cost Value in Forestry. — In this and succeeding chapters no distinction will be made between borrowed capital and owner's capital, nor between interest paid on borrowed capital and interest on owner's capital. The economic problem is to determine the total investment of capital required in an enterprise, and the rate which can be earned on this capital (§ 19). The relations between borrower and lender do not affect this dynamic problem but have to do merely with the static question of ownership of the capital involved and distribution of the income earned (§§ 19 and 20) (Fig. II).

Cost value is by definition the economic cost of production including a fair return to capital (interest), and is intended to furnish a basis for a selling price which will yield an adequate return on the investment (§ 23).

Cost and cost value are not identical. The difference between them is the interest. The same difference is distinguished between profit and entrepreneur's gain (§ 21). The actual cost of production is confined to the cash outlay, and an excess of cash income over this outlay is profit (§ 22). But to secure an entrepreneur's gain, profit must first be sufficient to cancel interest on invested capital, the surplus over this interest alone constituting the gain of the entrepreneur.

Where returns are delayed for two or more years, compound interest is added to true costs to obtain cost value and indicate this possible entrepreneur's gain. Owing to the excessively long periods involved in many forest investments, this element of interest may become the largest item in cost value, and raise important questions as to the rate which offers a fair basis for such calculations (Chapter VIII).

Cost value is neither a true cost (above) nor is it a true value (§ 26). It is merely a personal appraisal relative to an owner (§§ 25 and 27). In the absence of evidence as to true value, cost value is sometimes substituted to determine damages (Chapter XIV), insurance losses (Chapter XX), or condemnation values, but only when the factor of accumulated interest on cost can be

kept within reasonable limits by restricting the period, controlling the rate, or substituting simple for compound interest.

82. Capital Investment in Timberlands. — The outlay in a forestry enterprise must be separated into capital investment and operating costs. Viewed from the business standpoint (§ 14) the purchase price of a forest is a capital investment and the subsequent outlay for the realization of income is largely operating cost.

Timber is the principal source of income in such enterprises. Since the majority of forest investments include standing timber, and comparatively few start with bare land, the status of timber separate from land values must be understood in forest cost accounting. A cost account in forestry deals with a single operation in an effort to determine the cost value of timber. The problem presented may be to determine the cost value of:

1. An entire tract covering a period of deferred income and including stands of all ages and conditions contained in the area.
2. Parcels separately purchased, covering the period elapsing before sale or cutting.
3. Individual stands of timber, whose purchase price can be determined by alloting their proportion of total cost of purchase.
4. Even-aged stands of timber from origin to any subsequent age.

In the first three instances, the function of cost value is to measure the accumulation of interest on the investment, due to holding forest land and timber property, and thus gauge the possibility of gain on such investments.

Timber is capital subject to depletion as are minerals, but also capable of renewal or production as are manufactured goods or agricultural products. Timber capital is constantly changing in quantity and quality, either decreasing through losses or increasing by growth. The investor whose enterprise is based solely on the mining conception of depletion buys largely the mature timber and regards growth only as a factor of additional safety in realizing profit. The cost to him is that of holding for this profit, and the conception of production or of production cost is not attained.

A transitory stage is the purchase of young rapidly growing stands with the purpose of profiting from growth in volume, quality and price. The cost of purchase including timber is extended with interest over the period previous to the deferred sale or cutting. Production cost is still an unconsidered factor, since in few cases is any effort made at modifying or improving the crop.

But where the conception of the crop supersedes that of the mine, which is necessarily the case in growing timber on bare land or in establishing new crops following cutting, true production cost can be determined, and in addition the cost value or cost plus interest can be appraised. This last case resembles that of a manufacturing business which endeavors to distribute its operating costs including overhead expenses so as to determine the cost which each unit of product bears, and the consequent selling price which will permit of a profit over operating costs. When the compound interest is added, the cost value of growing an acre of timber is found, which means not that this is the true cost, or true value (§ 25), but that the appraiser desires the indicated rate of interest as a *return* on such an investment, and in this way can find out what the crop must sell for if he is to realize this return. It frequently happens that such cost appraisals, say at 6 per cent, are put out as true costs, as an argument against the possibility of growing timber as a business. Instead, it merely indicates that these individuals demand profits equalling this rate of income as a prerequisite for undertaking the enterprise.

The capital required in any of these forms of forest investments may be classed as fixed investment (§ 14) and working capital (§ 16). If the forest is being mined or exhausted, that portion of the forest investment which represents timber is depleted by the cutting of this timber whether or not growth occurs, for the renewal of the forest is so purely fortuitous and hazardous that it is not recognized as ~~affecting~~ offsetting depletion. If on the other hand a forest is being managed under a working plan which has for its object a sustained yield, and new crops are established on cutover lands, this form of management would permit of the abolition of the depletion charge and the retention of the investment in timber as part of the initial capital.

To determine the cost value, i. e. cost plus compound interest, for any forest investment over a period of deferred returns, this

interest is computed for all the invested capital, whether it be fixed or working capital, land, timber or operating costs. The distinguishing of one form of capital from another is merely a convenience in calculation. At the end of the period the total *actual investment* is limited to the purchase price plus all cash outlay for any purpose during the period, *omitting interest*. The total cost value exceeds this investment by the amount of this compound interest. On the books of a business organization the actual investment will be neither the one nor the other of these sums but will include all new capital required to pay interest on borrowed funds, and will exclude any interest on proprietor's capital (§ 19-§ 20).

Cost value may, therefore, be sought for:

1. A forest as a whole, in which case it deals only with enterprises which are not yet going concerns and covers the period of deferred income.
2. Speculative holdings in timber.
3. Production costs of growing timber.

In the first two cases timber value is a part of the capital investment. But when cost of production is sought, the investment starts with the capital required to grow timber, and subsequent outlay can be classed as operating costs.

Initial capital investment for timber production consists of land and of permanent structures and permanent improvements required for the conduct of the business. These include houses, barns, storehouses, lookout towers, telephone lines, roads, trails, fences, and any other improvements essential to the growing of the timber and its protection (§ 1). These investments must be pro-rated over the area which they serve and constitute an addition to the initial cost per acre.

83. Operating Costs—Establishment of Crop. — Operators who regard the forest as a non-renewable resource expect their profits solely from logging and manufacture, anticipate a depletion charge and seek to keep the cost of logging as low as possible. Under these circumstances they endeavor to determine the species and size of trees on each tract which will yield a profit if cut, over and above the costs of logging and manufacture (chapter XV). All such trees are cut and all merchantable portions yielding this profit are removed.

As timber becomes more valuable and the cost which it is possible to incur and still leave this margin of profit increases, the closeness of utilization and severity of the cutting steadily becomes greater until finally everything is taken and the forest values are completely wiped out (§ 5). Since the same tendencies which bring about this condition of denudation, namely high lumber prices and high stumpage values, are those required for and favorable to the production of timber crops, it is evident that unless investments are deliberately made in forestry and the business of growing timber purposely undertaken, *increased demand instead of creating a supply only tends to destroy this supply the more rapidly.*

This desire to convert the forest wealth into cash profits regardless of the future welfare of the race is an inherited tendency of our era of rapid development of lavish natural resources, and resembles the speculative desire to secure profit from capitalizing and selling future income rather than developing and earning such income (§ 42). The process of renewal of growth seemed too slow and the dividends too uncertain. The logging and manufacturing business itself is constantly over-extended and a considerable percentage of those engaged in it are operating on less than a profit margin and have nothing left with which to experiment in forestry. The more fortunate operators with lower costs prefer for the most part to re-invest their profits in other forms of enterprises. Thus the goal becomes the highest annual profit over a reasonable operating period and a liquidation of the entire investment as rapidly as consistent with this aim. No other course of action could have been expected under the conditions surrounding the development of this industry. Nevertheless, this result was largely unnecessary and arose from the inability of a pioneer society to think far enough ahead. They lacked the conception of a permanent use of the land and a permanent income, and through this lack, left a ruined resource in their wake. *These processes still continue with constantly increasing severity, wherever a deliberate investment is not made in forest production.*

By contrast, the land owner who is engaged in actual forest production knows that in order to continue the enterprise as a permanent business he must determine what constitutes the true net yield of the forest, and must re-invest such portions of the returns from timber cutting as are necessary to maintain the enterprise on a permanent basis. In agriculture, the value of crops

produced without care of the soil is not a true measure of net yields but leads to soil exhaustion. The cost of maintaining this soil fertility is a deduction from income. In forestry, corresponding deductions must be made from gross stumpage value to cover the cost of reëstablishing a crop of timber in place of that removed. These costs of renewal or maintenance of the forest must be kept as low as is consistent with securing the desired result promptly.

Slash disposal or reduction is a measure required both for fire protection and for securing better reproduction. It is similar to a capital expenditure in place of an increased annual outlay for fire patrol and prevention. It is classed as an operating cost. The problem of slash disposal is linked with that of close utilization in the woods. Where the standard of utilization is low and relatively large amounts of slash are left, the obstacle to proper protection thus imposed is serious. Close utilization reduces the cost of slash disposal as well as increasing the gross income from the timber crop.

Establishment of the crop must come either by seed or sprouts from the original stand, or by sowing or planting. Seed trees constitute an actual net cost only where such trees are sacrificed as a means of securing reproduction. This happens when they blow over or die and cannot be salvaged because the small quantity of lumber which they contain will not pay the cost of getting it out. Where such conditions prevail, seed trees of low value are left.

Where it is possible to salvage or cut seed trees, either by logging them whenever they are killed, or else by returning for them after the new crop is established, these trees may then be selected on the basis that their growth and increased value may carry the investment and perhaps return a profit. This would cancel the operating cost of establishment against the new crop.

Sowing seed is usually unsuccessful and hence is expensive because it produces no adequate return. Planting when required by failure of other possibilities requires actual and considerable outlay per acre for plants and field work. Cost is largely influenced by spacing or number set per acre which in turn must be governed by species, soil and vegetation, and by the possibility of making early thinnings.

The method of accounting for these costs of establishment depends directly on the ownership of the area. The tract is

usually part of larger forest holdings which constitute the capital assets in land of a forestry enterprise. If the area to be reproduced is retained as part of the whole, and not separated and placed under a different ownership or as a separate business enterprise, the costs of establishment are a current operating expense to be met annually from income. The unit of accounting is the entire forest and not the stand.

This distinction is of considerable importance. Since costs of reëstablishment come at the beginning of the rotation or period required to grow the new crop, it follows that if the business of forest production is regarded as having its origin on that date, these costs, including that of slash disposal, would yield no major income for the entire period, and must be compared with income by compound interest over this long period. On this basis the slightest increase in cost has a most serious effect on cost value (§ 89). If these same costs are assumed and carried as current operating expense for the year incident to perpetuating a going concern, they are absorbed in that year and are not reckoned on the books as requiring additional capital. This condition permits of more adequate expenditure for reëstablishment.

By incurring a heavy per acre cost for slash disposal to be computed at compound interest in the cost value of the succeeding crop, a high appraisal of this cost value results. Whether this item should be so charged, or treated as a necessary cost of logging similar to any other logging cost and hence deducted from stumpage value (§ 156), will be governed by the point of view of the operator. If engaged in destructive lumbering he will incur no such expense, but would *have to charge depletion instead,* and would be inclined to reckon slash disposal as an initial, not a final charge of production. The producer or grower might be inclined to confine cost of reëstablishment to planting costs or those directly expended on the new crop. Slash disposal is in fact a part of the cost of reëstablishing the crop, and except as it can be shown as a necessary cost of logging, as when it reduces the cost of skidding, it may be treated as an initial cost in cost value of growing timber.

84. Operating costs.—Annual Expenses.—*Protection.* Certain items of protection costs such as the construction of fire lookout towers, trails or roads, or even telephone lines, lookout cabins and fire lines should be added to the capital investment.

Annual costs for fire protection represent the wages of patrolmen or tower men and the cost of fire-fighting, of temporary equipment and the upkeep and repair of permanent equipment. These costs must be kept down by coöperation among all owners in a given region through associations and with state aid in supervision and funds. The average costs under such a plan run from 1 to 25 cents per acre annually, depending on the size of the tract and degree of intensity of the measures adopted.

Protection costs may be incurred against grazing animals by fencing, which should be treated as a capital expenditure and depreciated.

The cost of controlling insects or plant diseases may at times become an item.

Taxes on general property values are an annual charge. This is met by a going concern from income. As an element of cost value in crop production where returns are deferred, taxes constitute one of the major items of cost and are discussed in chapter XVIII. In general, property taxes tend to increase by readjustment of assessed values at more or less regular intervals. The sum of taxes and interest may be obtained once the conditions governing the future methods and probable rates of taxation are assumed.

Overhead or general expense in forestry covers the same items as for other business enterprises, which cannot be charged to specific operating costs but must be pro-rated over the entire operation. These are:

1. Cost of preparing plans for the management of the area, or working plans, including preliminary examination and final systematic plans. This item is properly chargeable to initial investment. Revision of plans may be made part of the general expense.

2. Office expense. This includes clerical help, office supplies, light, heat, telephone service, and such items as association dues or other legitimate office charges necessary to efficient administration. Other incidental expense may occur, as for instance, the cost of employing and insuring labor.

3. Supervision, or the salaries and expense of the forester and subordinates in such part as is not chargeable to specific costs of production or protection of the property.

The cost of supervision must bear a reasonable relation to the

possible net income and hence to the size of the property and the intensity of management. The success of an enterprise based on the maintenance of forest production depends on a different quality of supervision from that required to successfully handle the business of logging or lumbering, though in the main the same traits are required as for any business enterprise. Permanent success here rests on efficiency in securing protection of the growing timber, in establishing reproduction, in gauging the proper relation between forest outlay and income and in knowing what crops to produce and market. If instead the business is not one of forest production, supervision then concentrates on logging profits with a reasonable effort at fire protection for standing timber.

Trained supervision in forestry is an investment whose purpose is to increase profit. Training in general forestry is intended to develop executives who have the requisite grasp of business principles as well as a technical basis for guiding this class of enterprise, such as now manage the National Forests in units averaging a million acres each. The employment of skilled executives is an effort to reduce hazards and accomplish the objectives of the enterprise with the least expenditure, hence to produce the greatest ratio of profit, by assuring the owners of sound guidance in their new field of effort. The sincerity of this effort can usually be judged by noting the character, training and treatment of the men to whom it is committed and the degree of responsibility entrusted to them.

The larger the operation, the less the relative cost of supervision and the higher the quality of the personnel which can be afforded.

85. Operating Income. — The costs and profits from logging are usually treated separately from calculation of cost of producing timber, which carries the enterprise only as far as the value of the timber on the stump. This value may be secured directly by sale of stumpage, or indirectly through logging. For a discussion of stumpage values see chapters XV to XVII.

Incidental income in forest production can be secured from the products of thinnings made at intervals of from five to twenty years, dependent on the character of available markets and the closeness of utilization, and upon the frequency of successive logging operations possible on an area. Early and heavy thinnings tend to greatly reduce accumulating cost value by offsetting compound interest, and thus increase appreciably the rate earned in

forest investments (§ 108). In addition, income may be realized from the leasing of fishing or hunting rights and of camp sites, and from grazing or minor products of the forest. These items serve to reduce the annual operating costs.

86. Cost Value for a Forest which is a Going Concern. — For an entire forest constituting a going concern, *cost value* would be the investment cost of the capital assets or their investment value if they have been at any time re-valued, *plus interest for the year*. *Profit* for the year is net cash operating income, less depreciation and depletion when required by the character of the investment. *Entrepreneur's gain* is the margin left after subtracting from profit the interest on the invested cost.

The application of cost value in determining entrepreneur's gain will be shown below for this case. For the remaining problems in this chapter, entrepreneur's gain is discussed in § 111, Chapter XII.

For an established forest enterprise, cost value, profit and gain are found as follows:

Y = Income from major logging operations, computed or paid as value of stumpage.
Th = Income from minor operations, such as thinnings.
C = Cost of re-establishment of tree crop on areas cut over.
ee = Current annual operating expense including taxes, supervision and maintenance, less incidental income from leases, forage or fish and game, for the entire area of the forest (e is used for this item on one acre only).
I = Investment in property including land, timber and improvements, plus additions to capital assets.
I_v = Cost value.
P = Net operating income or profit.
G = Entrepreneur's gain.
p = Rate of interest.

Interest on operating costs is not usually charged for the current year, but as these costs require working capital, on which interest must be reckoned, they may be used to approximate the total interest-bearing investment.

Then cost value at end of 1 year is

$$I_v = (I + C + ee)1.0p$$

Profit for the year excludes interest and is equivalent to net operating income.

Income is $Y + Th$. Then,

$$P = Y + Th - (C + ee)$$

Entrepreneur's gain is found by deducting interest from profit.

$$\text{Interest} = (I + C + ee).op$$
$$G = Y + Th - (C + ee) - (I + C + ee).op$$
$$= Y + Th - I(.op) - (C + ee)1.op$$

e. g. A forest of 50 acres managed on a 50-year crop period yields annually a gross stumpage value of $500 from the final cut, and $100 from thinnings, with no net income from other sources. The annual cost of planting and slash disposal is $25, while for fire protection, maintenance and supervision, $50 per year is expended. Taxes amount to 2 per cent of the original cost which is $5,000, giving a tax of $100 per year. This gives a total operating cost of $175. Profit for year is then $600 — $175 = $425.

Adding $175 to the cost, for working capital, gives an interest-bearing capital of $5,175. Interest at 5 per cent is $258.75, which indicates an entrepreneur's gain of $425 — $258.75 = $166.25 per year, or the annual gain in excess of interest.

This problem may be modified to include the cost value of a single stand of timber which is managed on a system of annual selection of ripe trees, as is the case in some woodlots, or of larger tracts of forest. No element need be changed, but the assumption must hold that each item both of income and cost will recur annually at approximately the same value.

87. **Cost Value for a Forest with Deferred Income.** — When an investment in a forest is held for a period of years without realizing any income from timber, the item of interest assumes a larger importance. The owner will select such rate of interest as his estimate of the hazards involved, the relative advantages of forestry and the nature of compound interest indicates as a proper basic rate to use in computing the cost value of his investment including all items of cost whenever incurred, with interest for the remainder of the period.

The cost value of a forest which is held for n years with no net income is as follows:

I = Capital cost, or investment.
C = Annual cost of planting, cleaning or care of forest.
ee = Annual net cost of protection and other items, less annual incidental income, for the entire forest area; e is later used to indicate this item for one acre only.
I_{vn} = Cost value of forest in year n.

For n years the total of items C is nC and for ee is $n(ee)$. Compound interest must now be added to all of these items to get the appraised cost value for comparison with operating income.

If the costs are a matter of record, each class of items may be carried separately, or the sum of cost may be carried from year to year by adding actual costs and annual interest each year to the total cost value at its beginning. But in estimating or predicting future costs, the most practical method is to decide on an average annual expense. The total of these expenses can then be found by summing them up as annually recurring expense e, equivalent to an annual negative "rental" r. The sum of such a series of annual "rentals" at the end of a period n is equal to $\frac{c}{.0p}(1.0p^n - 1)$ (§ 57, I) which can be shown as: $\frac{e(1.0p^n - 1)}{1.0p - 1}$. In like manner, if C is incurred annually, its total cost value is $\frac{C(1.0p^n - 1)}{1.0p - 1}$.

The cost value of the capital investment in this year n is $I(1.0p)^n$.

The total cost value including operating costs in the year n is then

$$I_{vn} = I(1.0p)^n + \frac{C(1.0p^n - 1)}{1.0p - 1} + \frac{ee(1.0p^n - 1)}{1.0p - 1}$$

$$= I(1.0p)^n + \frac{(C + ee)(1.0p^n - 1)}{1.0p - 1}$$

$$= I(1.0p)^n + \frac{C + ee}{.0p}(1.0p^n - 1)$$

e. g. the above forest is purchased for $5,000, ten years prior to the date of sale. The owner will derive no revenue until the expiration of this period, but must expend each year the same sums for the same purposes as in the first example. Taxes are put at $75.00 per year for the period. The annual cost is, addi-

tions to planting $25.00, expenses $75.00, taxes $75.00, total $175.00. At 5 per cent the cost value is:

$$I_{vn} = 5000(1.05^{10}) + \frac{175}{.05}(1.05^{10} - 1)$$
$$= 5000(1.6289) + 3500(.6289)$$
$$= 10345.65$$

Such cost value can never appear on the books of a concern since this interest is not expended. Instead, cash costs and outlay are shown. The total actual investment is but $5000 + 10 \times \$175 = \$6750$.

88. Cost Value of Speculative Timber Holdings and Single Stands. — No expense for reëstablishing or planting the forest is incurred in this case. The initial cost plus carrying charges are computed with interest for whatever period and at whatever rate the owner desires to be informed on. The method is applicable to any specific stand for any period.

Let I = Cost of purchase
e = Annual expense plus taxes
I_{vn} = Cost value in n years

Then
$$I_{vn} = I(1.0p)^n + \frac{e(1.0p^n - 1)}{1.0p - 1}$$
$$= I(1.0p)^n + \frac{e}{.0p}(1.0p^n - 1)$$

e. g. A stand of timber may be purchased for $50.00 per acre, which will in 10 years yield 20,000 board feet per acre. Annual expenses for fire protection are 5 cents per acre. Taxes are 25 cents per acre. The cost value of the tract in 10 years will be, at 5 per cent:

$$I_{vn} = 50(1.05)^{10} + \frac{.30}{.05}(1.05^{10} - 1)$$
$$= 81.44 + 3.77$$
$$= 85.21$$

The cost value of the final stand of timber is $\frac{85.21}{20} = \$4.26$ per thousand board feet, with land having no value.

This problem can be modified to include the cost value of a tract of timber on which cuttings are made periodically, and forestry is practiced, thus incurring costs of reëstablishment C, possibly limited to slash disposal. In this case the cost value

reckoned from the date just after cutting to the year of the next cut is

$$I_{vn} = I(1.0p)^n + C(1.0p)^n + \frac{e}{.0p}(1.0p^n - 1)$$

in which I is the cost, purchase price or investment value of the tract at the beginning of the period, and C the cost of assuring the continuance of productivity.

89. The Cost of Producing a Timber Crop. — The cost of production for timber means the cost of growing the crop. This can only be determined accurately when the crop is even-aged, which permits the cost of crops of different ages to be separated by reason of being on separate areas. When this is true the cost can be segregated for the period of production and this total cash cost or investment once determined, cost value appraisals based on these costs are possible.

The cost value of such a crop is

S_c = Cost of land and pro-rated cost of permanent improvements.
C = Cost of establishing the crop, including slash disposal, planting, etc.
e = Net annual expense
n = Period required to grow the crop

The total cost value I_{vn} of the property at the end of the period includes the original investment in land S_c and is:

$$I_{vn} = S_c(1.0p)^n + C(1.0p)^n + \frac{e}{.0p}(1.0p^n - 1)$$

e. g. Abandoned farm land is purchased for $5.00 per acre, and planted to pine at a cost of $15.00. The average for protection, taxes and supervision is estimated to be 30 cents per acre annually. The timber is cut at 50 years and yields 40,000 board feet. The cost value of the investment in land and timber in that year is:

$$I_{vn} = \underset{\text{Land}}{5.00(1.05)^{50}} + \underset{\text{Planting}}{15.00(1.05)^{50}} + \underset{\text{Annual Expense}}{\frac{30}{.05}(1.05^{50} - 1)}$$

$$= 5.00(11.4674) + 15.00(11.4674) + 6.00(11.4674 - 1)$$
$$= 26.00(11.4674) - 6.00$$
$$= 298.15 - 6.00 = 292.15$$

To obtain true cost value for producing this crop of timber fixed investment must now be deducted.

Let T_{vn} = Cost Value of the timber crop
The fixed investment is the land, S_c

Then $$T_{vn} = S_c(1.0p)^n + C(1.0p)^n + \frac{e}{.0p}(1.0p^n - 1) - S_c$$

Deducting the investment in land of $5.00, the net cost of the timber crop above is $287.15.

The cost value per thousand board feet is:

$$\frac{287.15}{40} = 7.18$$

which indicates that a stumpage price of $7.18 will return all operating costs and pay 5 per cent compound interest on the investment for 50 years (§ 76).

The item of annual expense e is totalled for n years as a rental by capitalizing it at $\frac{e}{.0p}$ and finding the compound interest on this capital. The practical application of this formula may be best visualized by substituting E for the capitalized value $\frac{e}{.0p}$ and regarding this as an endowment fund, the interest on which just equals or takes care of the annual expenses, leaving the principal intact at all times. In the case of certain institutional forests which are not yet going concerns, the donors have established just such endowments, and this has also been done in the case of buildings given to colleges, in order that their maintenance may not be a charge on the income of the institution. E can if desired be substituted, in these formulae, for $\frac{e}{.0p}$. The annual expense then becomes

$$\frac{e}{.0p}(1.0p^n - 1) = \frac{e}{.0p}(1.0p)^n - \frac{e}{.0p}$$
$$= E(1.0p)^n - E$$

and
$$T_{vn} = S_c(1.0p)^n - S_c + C(1.0p)^n + E(1.0p)^n - E$$
$$= (S_c + C + E)1.0p^n - (S_c + E)$$

Effect of incidental items of income and expense. Thinnings received in any year t and designated as Th_t will have a "negative" effect offsetting cost value at n years, of

$$Th_n = Th_t(1.0p)^{n-t}$$

Should any irregular item of expense such as a cleaning occur,

which cannot be treated as an annual "rental," this must be given the same treatment as C. Let the expense C_d occur in the year d. This accumulates interest for the remainder of the period, $n - d$ years, and its total cost value is $C_d(1.0p)^{n-d}$ which would be added to the above values. Adding these items to the formula gives, for total cost value of property,

$$I_{vn} = (S_c + C + E)1.0p^n + C_d(1.0p)^{n-d} - Th_t(1.0p)^{n-t} - E$$

For net cost value of the timber crop:

$$T_{vn} = (S_c + C + E)1.0p^n + C_d(1.0p)^{n-d} - Th_t(1.0p)^{n-t} - (S_c + E)$$

e. g. In the above problem a cost of \$8.00 per acre is incurred in the 5th year for cleaning or liberating the pines from grey birch. At 30 years a thinning will yield an income of \$25.00 per acre, and at 40 years a second thinning yields \$50.00 per acre. The cost value of the timber crop, with $E = 6.00$ or $\frac{.30}{.05}$, is

$$\begin{aligned} I_{vn} &= (5.00 + 15.00 + 6.00)1.05^{50} + 8.00(1.05)^{50-5} - \\ &\quad 25.00(1.05)^{50-30} - 50.00(1.05)^{50-40} - (5.00 + 6.00) \\ &= 26.00(11.4674) + 8.00(8.9850) - 25.00(2.6533) - \\ &\quad 50.00(1.6289) - 11.00 \\ &= 298.15 + 71.88 - 66.33 - 81.44 - 11.00 \\ &= 211.26 \end{aligned}$$

This gives the final crop a cost value of $\frac{211.26}{40} = \$5.28$ per thousand. The cost value of the property is \$216.26 by addition of the land investment of \$5.00.

The cost value of a crop of timber can of course be determined for any year a during its growth and previous to maturity by substituting this year for n in the calculation and omitting all items of either cost or incidental income which occur subsequent to this date.

e. g. the cost value of the above crop at 35 years, at 5 per cent, is:

$$\begin{aligned} T_{va} &= (5.00 + 15.00 + 6.00)1.05^{35} + 8.00(1.05^{30}) - \\ &\quad 25.00(1.05)^5 - (5.00 + 6.00) \\ &= 26.00(5.5160) + 8.00(4.3219) - \\ &\quad 25.00(1.2763) - 11.00 \\ &= 140.08 \end{aligned}$$

In this example, only the first thinning at 30 years is credited, as the second falls in the future.

CHAPTER X

CAPITAL VALUE OF FOREST PROPERTY

90. Considerations affecting Capital Value. — An appraised *use value* is derived wholly from future net operating income (§ 27). The *capital value* thus sought is found by discounting this future income. This value is therefore affected by the discount rate. As the rate drops, the capital value increases (§ 52) and vice versa. An increase in the value of property (§ 44) may be due primarily to an increase in prospective income, but on the other hand it may be brought about entirely by a lowering of the rate of discount as the result of increasing public recognition of the stability and certainty of the income and an increased demand for the property. As capital value is always present value it must be based on a *present estimate of future net operating income* and upon a present decision as to the rate to use in discounting this income (§ 36). Whatever future changes in either the amount of income or rate of interest can be foreseen must be considered now, and are taken into account in appraising capital value.

Future costs are negative and have the same basis as future income, that of past experience and future probability. These costs are discounted and subtracted from discounted gross income to get net or true capital value.

In determining the capital or use value of forest property, the same principles apply as to all other income-producing property. All property may be grouped into two general classes, that which is consumed or rendered useless in the process of yielding income and that which can be preserved intact, and hence is capable of continuing to produce income indefinitely. Manufactured articles are in the former class, while productive soil is in the latter class, which is also shared by permanent transportation facilities.

No property will continue to produce income indefinitely unless properly maintained, whether it be soil or railroads, but by first providing for this maintenance, the assumption can be made that the resultant net income will never cease, or, what amounts to the same thing, that any possible destruction of the property or cessation of income is so far in the future that it has no appreciable effect upon discounted value of the expected future net income.

The case is quite different when the income is of such a character as to be in effect a depletion of capital or an exhaustion of value, as in the case of mining. The total quantity, duration and value of the expected income can in this case be appraised and its present equivalent capital value determined almost as definitely as one would discount a note or figure the present value of an annuity running for twenty years.

A forest falls in the second group. When properly managed, the forest soil never loses its fertility or capacity to grow successive crops of timber of quality equal to that grown in the first instance. But this assumes that when a timber crop is cut, a new crop will be established in its place. Based on this assumption, which is the foundation of the business of forestry, the capital value of forest property whether it be mature timber, immature timber, bare soil, or contains all of these elements, must be found by including the *discounted value of these future or succeeding crops as part of the value of the property*. To assume that the capital value of a tract of timber managed under forestry principles was confined to the value of the standing timber, would be as wrong in principle as to hold that the value of a farm was only equal to that of the crop of wheat expected in the ensuing season. Farm values are capitalized by assuming a perpetual annual yield of crops, and for the same reason forest values must be so treated whenever timber is regarded as a crop and handled accordingly.

The capital value of either farm or forest is thus found by using the formulae for obtaining the sum of values of a perpetual or never-ending income or "rental" (§ 57) instead of that for an income which recurs only for a certain period and then ceases.

One may ask how it can be assumed that this income will not only continue indefinitely but will remain the same in value for successive payments. The answer is that if future changes in value can be foreseen with sufficient certainty the appraiser is privileged to adopt these altered values in obtaining his estimate of capital value. An unchanging value is assumed for land because it is a safer and more conservative guess at the future than advancing values, while depreciating values assume mismanagement of the property or economic decay. We know that values will change and that the appraisal of capital value for to-day must be revised in a month, a year or a decade, but for to-day it is our best guess and will have to do. The entire economic and business structure

of value and prices rests upon intelligent appraisals of probable but uncertain future net income.

When the maturing of subsequent timber crops, though occuring at regular intervals, is long deferred as in a 40-80 year rotation, the present discounted or capital value of all future crops subsequent to the first is so small that the effect of any possible future increase or decrease in the value of such crops on the present or capital value of the property as a whole is very small.

91. Capital Value of a Forest Producing Annual Income. — Once the true net annual operating income of a forest can be determined, its capital value may be computed for any given rate of interest by the formula $\frac{r}{.0p}$ (§ 57—V), which gives the sum of values of an income that can continue forever without loss to the producing capital.

In a forest which is a going concern, i. e. produces a yield of timber each year sufficient to more than meet all costs not merely of protection and administration but of reëstablishing the stand on the cutover areas, every item of expense which would occur during the production of any one crop of timber (§§ 83 and 84) and every item of incidental income (§ 85) *will all occur during the current year* on some part of the area *and will recur in every subsequent year,* for the reason that there must be as many separate crops of timber as there are years in the average age of the mature crop or else the forest is not on a *sustained yield basis* as a going concern in forestry should be.

Let $Y =$ yearly total or gross income from final cuttings, on the entire forest.

$Th =$ cash returns from thinnings bringing in positive revenue.

$C =$ cost of establishment of a new crop.

$C_a =$ cost of weeding or other silvicultural measures designed to improve the quantity or quality of future yields.

$ee =$ annual expenses for taxes, protection and supervision over the entire forest.

$p =$ rate of interest.

$V_0 =$ capital value.

Hence, if $Y =$ annual gross income from final cut for the year,

this income, repeated every year, forms the series of discounted values $\frac{Y}{1.0p} + \frac{Y}{1.0p^2} +$ etc., whose sum is $\frac{Y}{1.0p - 1}$ which equals $\frac{Y}{.0p}$. In the same way, thinnings *Th*, made on the forest each year, give an annual income whose capital value is

$$\frac{Th}{1.0p - 1} = \frac{Th}{.0p}$$

The cost of reëstablishment and that of cleaning or weeding recur annually in the same manner and can be added together as $C + C_a$ whose value capitalized is $\frac{C + C_a}{.0p}$

Annual expense *ee* covering the entire forest has the capital value $\frac{ee}{.0p}$. Subtracting these capitalized costs from the capital value of income or credits gives net capital value V_0

$$V_0 = \frac{Y + Th - (C + C_a + ee)}{.0p}$$

The accuracy of the capital value obtained by such an appraisal depends on whether the net income for the year or even the average for a period of years represents what can be obtained from this forest continually, or instead, is greater or less than this possibility. In the latter cases, since net income will decrease or increase, it cannot be capitalized as if perpetual and unchanging and the true value of the forest is not as represented by this formula. The income required to obtain this correct value is the so-called *normal yield,* and the forest which will actually produce it from now on is the *normal forest,* which is the goal of financial management.

E. g., a 50 acre forest of loblolly pine has been under management for so long a period that the balance between capital and income has been practically attained. The crop period is 50 years, and the average yield is 23,000 board feet per acre, worth $10.00 per thousand board feet on the stump or a total per acre of $230.00 less a 10 per cent yield tax of $23.00, giving a net income of $207.00 per acre. Seeding is obtained from adjoining trees and the only additional cost is 10 cents per acre annually for taxes on land, and 10 cents per acre for fire protection, a total of 20 cents, which

on 50 acres equals $.20 \times 50$, or $10.00 per year. This with the yield tax totals $33.00 annually.

Then $$V_0 = \frac{Y + Th - (C + C_d + ee)}{.0p}$$

At 5 per cent,

$$V_0 = \frac{230.00 + 0 - [0 + 0 + (10.00 + 23.00)]}{.05}$$

$$= \frac{230.00 - 33.00}{.05}$$

$$= \frac{197.00}{.05} = \$3940.00$$

At 4 per cent,

$$\frac{197.00}{.04} = \$4925.00$$

At 3 per cent,

$$\frac{197.00}{.03} = \$6566.66$$

If the sale value coincides with these higher appraisals it means that if investments in second growth loblolly pine have attained a reputation as being safe and profitable, investors will pay more for such property because of the diminished hazards even though the prospective income is not changed.

This example can be expanded by the appraiser to cover any and all possible items of future expense or future income. If for instance a market for cordwood exists, and thinnings at 25 years yield 10 cords worth $2.00 per cord on the stump and at 35 years an additional 10 cords can be cut having the same value, these additional cuttings on a 50 acre forest can be made on 1 acre each year, adding $40.00 per year to gross income, and increasing the value of the forest by $\frac{\$40.00}{.05} = \$800$, making its total capital value at 5 per cent $4,740. Each increase in expense would reduce this appraised capital value in like manner, unless offset by correspondingly increased income. Doubling this expense gives a loss in value of

$$\frac{.20 \times 50}{.05} = \frac{10.00}{.05} = \$200$$

Sale value will coincide most closely with whichever of the appraisals given above best interprets the public idea of the discount rate which should apply to such risks. It may easily happen that this rate is 6 or even 7 per cent, in which case the purchaser, in order to have a chance to earn the higher rate, must buy for less than $4,740.

92. Capital Value of a Forest Whose Income is not Continuous. — A forest is cut over without regard to growth, and income will terminate in a period of years which can be assumed as n. If this income is realized in approximately equal annual quantities it constitutes an annual "rental" of n terms, whose present (discounted) or capital value is:

$$\frac{r(1.0p^n - 1)}{.0p(1.0p^n)} \qquad (\S\ 57\text{—III})$$

Y = annual cut including all merchantable young timber. What is not cut is destroyed by fire.

ee = annual expense, confined to taxes. This tends to diminish and can be averaged. There are no costs of reëstablishment.

V_0 = capital value at p per cent.

Then $$V_0 = \frac{(Y - ee)(1.0p^n - 1)}{.0p(1.0p^n)}$$

e. g. The forest of loblolly pine above described (§ 91) will be cut clean in fifteen years. The merchantable saw timber will cover 30 acres and cut at double the rate of the preceding forest, but at an average age which is less than 50 years, will yield 40,000 board feet per year on 2 acres, worth $400.00 per year. Meanwhile the timber under 30 years of age is cut for pulpwood at the rate of 1 acre per year, and yields an annual cut of 50 cords at $2.00 worth $100.00, or a gross of $500.00. Taxes are considered as diminishing with the progress of cutting and average $20.00 per year, and nothing is spent on fire protection, consequently fires destroy all timber under 15 years of age and all reproduction. The net income is $480.00 per year.

$$V_0 = \frac{(500.00 - 20.00)(1.05^{15} - 1)}{.05(1.05)^{15}}$$
$$= \frac{480.00(1.0789)}{.1039}$$
$$= \$4984.33$$

Compared with the value of $4,740 for perpetual operation, this shows an apparently slight financial advantage to the owner in destroying the forest if the discount rate is 5 per cent.

As the rate of interest falls, due to better understanding and control of hazards, the comparative values based on the annual net income of $237.00 or 197.00 + 40.00 for perpetual operation, compared with the above revenue is

Per cent	Capital Value for Perpetual Operation	Capital Value for Destructive Operation
5	$4,740.00	$4,984.33
4	5,925.00	5,336.64
3	7,900.00	5,730.02

The true significance of this comparison lies in the fact that the choice of destructive logging withdraws wealth from the forest without replacing it, forcing the owner to invest in the remaining diminished opportunities for enterprise afforded by other resources of a different character and unfamiliar to him, or else to join the ranks of the money lenders and retire from industry. Owing to this depletion on the one hand and production on the other, a difference in value in favor of the permanent operation soon appears and steadily increases as the second forest is cut over and destroyed, until in the 15th year, while the first forest remains at its full original value, the second has become worthless and is a liability since the land is non-agricultural and taxes continue. In the 15th year, as it is, the first forest is still worth $4,740 plus the land value, and will continue to pay $33.00 per year tax, while the second has no taxable forest value and if taxed at $10.00 annually, as before, on value of the land may eventually be relinquished and taken by the state for unpaid taxes, a process that is occurring on a wholesale scale in certain northern pineries to-day.

Until recently, in many forest regions, the capital value shown by destructive logging was probably in excess of that obtained by permanent forestry, due primarily to the existing hazards (Chapter XIX) and consequent high discount rate. This condition is rapidly changing, but as long as it existed, operators were indifferent to loss of future values in forestry, preferring the policy of withdrawing or realizing on the forest capital by the mining process, to seek reinvestment in other virgin forests, or when these were exhausted, in other fields.

Much of the destruction which still goes on is carried out blindly under the impression that the owner cannot afford to conserve the young growth and reproduction, or cannot control the hazards incident to growing timber from seed. The most rational explanation of this neglect and waste of values is reluctance to think out new factors. Here is where the utility of the trained forester comes in, namely, in accurately appraising and properly conserving values in property which would otherwise be lost through ignorance.

93. Capital Value of Single Stands of Timber whose Income is Deferred. — The value of single stands of timber will be treated in this paragraph as including that of the soil, i. e. the value of the whole property.

If this property is to be regarded merely as so much standing timber, not renewable, its capital value includes only the discounted net value of the future income from the sale or cutting of the standing crop, to which may be added whatever price the denuded soil will bring at that time, also discounted.

If Y is the ultimate sale value of the timber, n years from now, its gross value now is $\frac{Y}{1.0p^n}$. The net or true capital value requires the deduction of future intervening costs, which in this case are confined to annual expenses. Their capital for n years is:

$$\frac{e(1.0p^n - 1)}{.0p(1.0p)^n} = E - \frac{E}{1.0p^n}$$

If the land can be sold after cutting, this is equivalent now to a capital value of $\frac{S_0}{1.0p^n}$. The present capital value of this property is then:

$$V_0 = \frac{Y}{1.0p^n} + \frac{S}{1.0p^n} - \frac{e(1.0p^n - 1)}{.0p(1.0p)^n}$$

Substituting E for $\frac{e}{.0p}$ this expression reduces to

$$V_0 = \frac{Y + S}{1.0p^n} - \left(E - \frac{E}{1.0p^n}\right)$$

$$= \frac{Y + S + E}{1.0p^n} - E$$

E. g. A stand of pine is worth $230.00 per acre in 10 years. The

land will sell for 50 cents an acre. Annual expenses are 30 cents, which at 5 per cent give a capital value of $6.00.

This stand of timber has a net capital value, including land, of

$$V_0 = \frac{230.00 + .50 + 6.00}{1.6289} - 6.00$$
$$= 145.19 - 6.00 = \$139.19$$

When forestry, or reëstablishment of the crop is practiced, the capital value is found for the property as a whole, soil and timber together, by the principles set forth in (§ 92), by discounting not merely the value of the first crop, but of all future crops, treating this future income exactly as one does any other recurring perpetual income. Two factors are important in this problem, first, how long a period elapses between payments, and second, for what year or stage of this period is the value sought. As shown (Fig. VI) an income which is payable at fixed intervals accrues during this interval, adding steadily to capital value until it is paid or withdrawn, when value drops by exactly the amount of the payment, only to again begin its accretion in anticipation of the next payment. This process may be visualized as similar to the actual physical growth of a crop of timber up to the time of harvest, when the property remaining falls in value by just the worth of the timber removed. If all this timber is cut, the residual property is the bare soil, but if only a part is removed, what remains may have a large value as young timber.

A single stand of timber is not necessarily even-aged, but may contain many different ages of trees, and be capable of yielding income at much shorter intervals than that representing the time to grow a crop of trees from seedlings to maturity. If the amount of the recurring yield and its value can be determined for the year of cutting, its capital value is found by the universal formula for capitalizing perpetual rentals.

$$V_0 = \frac{r}{1.0p^n - 1} \qquad (\S\ 57\text{—VI})$$

Three cases are possible. In the first, it is assumed that trees can be cut from the stand each year without depleting the forest. Substituting 1 for n, the value corresponds to $\frac{r}{1.0p - 1} = \frac{r}{.0p}$ (§57—V). If as is more apt to occur, the stand can or will be cut

over only at longer intervals, m years as for instance, every decade, the value of the capital, *without accrued income*, is $\frac{r}{1.0p^m - 1}$. It is evident that this value is correct only for a year just after the cutting is completed. Finally, if the crop is even-aged, cut clean and renewed every n years, the value of the land, which is all that remains just after cutting, is $\frac{r}{1.0p^n - 1}$ and in the interval n the property value again increases until the value of the crop has completely accrued and is added to that of the land capital value.

The first of these three cases has been treated as for an entire forest in (§ 92). To determine the capital value of a forest capable of yielding a cut Y every m years without depletion, the process is as follows. Slash disposal and reëstablishment of the crop on cutover areas, whatever this expense may be, constitutes in effect a reduction of income from stumpage, or a reinvestment of this sum as an operating cost for the year. The net income which can be discounted is therefore not Y, but, if C represents this cost, it is $Y - C$. Just before this stand is cut there is present its sale value Y which will net Y minus the sum to be spent for slash disposal and planting or whatever measure is needed. In m years this same net income recurs, and continues at the same intervals. The sum of these values is $\frac{Y - C}{1.0p^m - 1}$, which is

$$\frac{Y - C}{1.0p^m} + \frac{Y - C}{1.0p^{2m}} + \cdots\cdots \frac{Y - C}{1.0p^{\infty}} \qquad (\S\ 57\text{—VI})$$

Just before cutting, the value of the property includes the net expected income $Y - C$ which added gives

$$Y - C + \frac{Y - C}{1.0p^m - 1}$$

The annual expenses occurring in the future must be deducted to get net value. These occur for every year not merely for the first crop but for each succeeding crop perpetually. This capital value or cost is $\frac{e}{1.0p - 1} = \frac{e}{.0p} = E$. Deducting this cost, the net capital value V_m is for the year just before cutting,

$$V_m = Y - C + \frac{Y - C}{1.0p^m - 1} - E \text{ usually shown as}$$

$$= Y + \frac{Y - C}{1.0p^m - 1} - (C + E)$$

For the same year just after cutting, the value V_0 is

$$V_0 = \frac{Y - C}{1.0p^m - 1} - (C + E)$$

E. g. A stand of mixed seedling hardwoods will yield a cut of 1,000 board feet per acre every 10 years without depleting the wood capital. The timber is of high quality, bringing $20.00 per thousand board feet on the stump. Fire protection and taxes cost 50 cents per acre annually. In this case no expense C is incurred, hence $C = 0$. Property is worth at 5 per cent, just after cutting the decennial yield:

$$V_0 = \frac{20.00}{.6287} - \frac{.50}{.05} = 31.80 - 10.00 = \$21.80$$

Just previous to cutting the crop the value of the stand is that of the cut $20.00 plus the residual value, $21.80. Total value

$$V_n = \$41.80 \text{ per acre.}$$

Capital value of a stand of timber for any year a. During any year between successive cuttings, the value just after cutting increases until it reaches a maximum just previous to the next cut. The first income or rental Y falls due for the first time at the end of a period shorter than m years. Let the year in which value is sought be a. Then a measures the period elapsing since the last cutting and $m - a$ the interval previous to the next cut. Omitting the item of expense, the value of this cut in the year a is $\frac{Y - C}{1.0p^{m-a}}$ That of the next succeeding cut is $\frac{Y - C}{1.0p^{2m-a}}$ and the final crop $\frac{Y - C}{1.0p^{\infty}}$. The sum of values (§ 57—VII) is best found by transferring a to the numerator giving $\frac{(Y - C)1.0p^a}{1.0p^m - 1}$ from which is deducted E to obtain net value.

E. g. in the 6th year previous to cutting the crop in the last problem, the period since the last cut is 4 years. Then, deducting

$$E = \$10.00$$

$$V_0 = \frac{20.00(1.05^4)}{1.05^{10} - 1} - 10.00$$

$$= \frac{20.00(1.2155)}{1.6289 - 1} - 10.00$$

$$= \$38.65 - 10.00$$

$$= \$28.65$$

94. Capital Value of an Even-aged Stand of Timber. — In this case the principal item of income is from the final harvest in the year n which will be repeated each n years. As seen (§ 88) other items of income may occur, while the net income is found only after deducting all future costs.

No element of past cost or past income can enter into the determination of any capital value since the latter is *not a cost value.* In cost value appraisals costs are a past occurrence and have a positive value. In capital value, costs are a future item *decreasing* these values, and have a negative value. When a cost has been passed or put behind in point of time, both future value and past cost are equally increased thereby, because this item need no longer be expended in order to get the income; and is added to cost value instead. This relation can be made clear by forming *the equation of entrepreneur's gain* balancing the cost value and capital value in the present moment (§ 111). Then for a given year:

(Past costs — past incidental income) with interest + entrepreneur's gain = (future income — future costs) discounted.

For a subsequent year, the costs for the intervening period have been transferred from right or future, to left, or past side of this equation, *thus changing from negative to positive value,* and increasing both cost value and capital value equally. The obvious error consists in thinking of future costs as positive instead of negative, i. e. transferring them without changing the sign. A similar error would be incurred if past incidental income were treated as a positive item increasing cost value.

In obtaining this capital value every item of either income or cost which normally occurs in raising a crop will be assumed to occur again in the future each time a new crop is raised. Those

items which have yet to be incurred for the present crop affect the present value of the income from this crop. Those *which already have occurred do not* affect this first income in any way. In fact, just previous to cutting the timber, the income expected is obviously equal to the *full net stumpage value without any deduction whatever for past costs of growing it.* Value, not profit, is being determined. But items which have already been incurred for this crop will appear again and affect the *present value of the next succeeding crop* and continuously thereafter.

Let the crop period $= n$
age of crop $= a$

Then a is the period from the formation of the crop until the present year, and $n - a$ the interval from the present year until the final crop rental is paid.

The value of future items of either expense or income can in fact be calculated by discounting directly to this present year a, but to simplify the process each item is actually computed forward to a given year which is just n years in the future, and the net value of the operating income as of that year is determined, and then capitalized by the universal formula

$$\frac{r}{1.0p^n - 1}$$

This process can best be illustrated by Fig. VIII, p. 124.

Taking a crop rotation period of 50 years equal to n, and determining the capital value of the property for the 35th year, equal to a, the simplest case is where no incidental items of cost or of income occur. The value of the net yield $Y - C$ is then

$$\frac{(Y - C)1.0p^a}{1.0p^n - 1} = \frac{(Y - C)1.0p^{35}}{1.0p^{50} - 1}$$

thus covering cost of reëstablishment. Annual expense e is capitalized as usual, at $\frac{e}{1.0p - 1} = \frac{e}{.0p} = E$

giving a value for year a of

$$V_a = \frac{(Y - C)1.0p^a}{1.0p^n - 1} - E$$

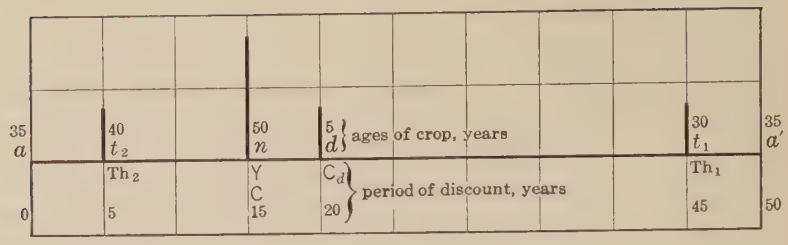


FIG. VIII.—Method of discounting net income from a timber crop as a rental to determine its value for any year, a.

The value of any item as a recurring rental is found (1) by extending it to year a' by factor $1.0p^x$ in which $x =$ period between occurrence of item and a', (2) obtaining net value of all items for year a', (3) discounting by $\frac{1}{1.0p^n - 1}$ as a perpetual rental every n years falling due in year a'.

e. g. for thinning Th_2, $x = 45$

$$= 50 - 40 + 35$$

$$= n - t_2 + a$$

$$\text{Value of } Th_2 \text{ in year } a = \frac{1.0p^{n-t_2+a}}{1.0p^n - 1}$$

e. g. A plantation of white pine costs $15.00 per acre for establishment. The yield at 50 years is 40,000 board feet at $10.00 per thousand. Annual expenses are 30 cents per acre. Based on forestry value, or periodical renewal by planting after each crop is cut, the capital value of the property when the crop is 35 years old, at 5 per cent, is

$$V_{35} = \frac{(400.00 - 15.00)1.05^{35}}{1.05^{50} - 1} - \frac{.30}{.05}$$

$$= \frac{385.00(5.5160)}{11.4674 - 1} - 6.00$$

$$= 202.85 - 6.00 = \$196.85$$

Only with the introduction of items falling in years during the growth of the crop, some previous to the year of valuation and others subsequent to that year, is confusion apt to arise as to the treatment of these items. One rule applies to all cases. Any item must be capitalized from the first year it occurs in the *future* only, whether this be for the standing crop, or not until the next crop is grown. In the above example a cleaning may occur in

the year d, or 5th year, and thinnings in the years t_1 and t_2, or at 30 and 40 years respectively, the first of which falling previous to the year a, or 35th year, goes over to the succeeding crop. Then the present or capital value of each item is, in the year a,

For final harvest:

$$\frac{Y(1.0p)^a}{1.0p^n - 1} = \frac{Y(1.05)^{35}}{1.05^{50} - 1}$$

For first thinning, which does not occur until the next crop:

$$\frac{Th_1(1.0p)^{a-t_1}}{1.0p^n - 1} = \frac{Th_1(1.05)^{35-30}}{1.05^{50} - 1} = \frac{Th_1(1.05)^5}{1.05^{50} - 1}$$

For the second thinning, which is still to be made:

$$\frac{Th_2(1.0p)^{n-t_2+a}}{1.0p^n - 1} = \frac{Th_2(1.05)^{50-40+35}}{1.05^{50} - 1} = \frac{Th_2(1.05)^{45}}{1.05^{50} - 1}$$

For the expense C, or establishment of the crop:

$$\frac{C(1.0p)^a}{1.0p^n - 1} = \frac{C(1.05)^{35}}{1.05^{50} - 1}$$

For the expense of a cleaning occurring in year d:

$$\frac{C_d(1.0p)^{a-d}}{1.0p^n - 1} = \frac{C_d(1.05)^{35-5}}{1.05^{50} - 1} = \frac{C_d(1.05)^{30}}{1.05^{50} - 1}$$

For the expense e occurring annually forever, since $n = 1$:

$$\frac{e}{.0p} = \frac{e}{.05}$$

The net capital value of a stand of timber V_a including the soil and standing timber for any year a is thus:

$$V_a = \frac{\left\{ \begin{array}{l} (Y - C)1.0p^a - C_d(1.0p)^{a-d} + \\ Th_1(1.0p)^{a-t_1} + Th_2(1.0p)^{n-t_2+a} \end{array} \right.}{1.0p^n - 1} - E$$

E. g. The above plantation of white pine, which costs $15.00 per acre, incurs an additional $8.00 at 5 years of age for cleaning. At 30 years a thinning yields $25.00 per acre and at 40 years a similar thinning yields $50.00 per acre. The final yield is 40,000 board feet at $10.00 per thousand. Annual expenses are 30 cents per acre.

When this crop is 35 years of age, the property, including the young timber and soil, has a capital value, at 5 per cent, of

$$V_a = \frac{\left\{ \begin{array}{l} (400.00 - 15.00)1.05^{35} - 8.00(1.05)^{35-5} + \\ \quad 25.00(1.05)^{35-30} + 50.00(1.05)^{50-40+35} \end{array} \right.}{1.05^{50} - 1} - \frac{.30}{.05}$$

$$= \frac{\left\{ \begin{array}{l} 385.00(5.5160) - 8.00(4.3219) + \\ \quad 25.00(1.2763) + 50.00(8.9850) \end{array} \right.}{10.4674} - 6.00$$

$$= \frac{2123.66 - 34.57 + 31.91 + 449.25}{10.4674} - 6.00$$

$$= \frac{2570.25}{10.4674} - 6.00$$

$$= 245.54 - 6.00 = \$239.54$$

95. Capital Value of Bare Soil. — If the year for which capital value is sought is that just following a clear cutting, this value happens to coincide with the bare soil, so is in this case termed the soil value. If, however, reproduction has been secured by the so-called shelterwood method and is already ten years old, the value would obviously include these seedlings, just as the value of a stand containing several age classes would include the remaining standing timber, though taken just after a cut.

The net operating income from the timber and the discount rate will determine the soil value, and not any "intrinsic" element in the soil itself which separates it in any way from the timber or young growth upon it. This is best shown by the effect of a period of forced waiting which delays this harvest. In eastern white pine stands when cut over, a weevil, Pales sp., is attracted by the freshly cut stumps and attacks and destroys young pine seedlings, necessitating a delay of about four years before planting. If bare soil just after cutting has a capital value of $20.00 per acre provided it can be planted at once, this same bare soil in this year is worth at 5 per cent but $\frac{\$20.00}{1.05^4}$ or $16.45 per acre if this enforced delay in planting is required.

This appraised shrinkage in value may or may not be reflected in loss of sale value (§ 98). The appraised capital value of bare soil as of any other condition or age of a stand is exactly equivalent to the sum of values of future net operating income discounted by a chosen rate of interest and is a mere personal calculation of value, not established as market value.

The capital value of bare forest land just following clear cutting is as follows. The year a now equals o, the year n falls at n years distant from a.

Where there are no incidental items of expense or of income the elements are: final crop Y; cost of establishment C; and capitalized annual expenses $\frac{e}{.0p} = E$. If bare soil value is sought, the cost of reëstablishing the crop is obviously excluded from this value, and although it will be incurred at once, it is a "future" item, occurring first for first crop to be grown. This separates Y from C in this formula, which can be handled in one of two ways; first as $\frac{Y - C}{1.0p^n - 1}$ for all future net income, subtracting the initial cost C for the first crop, giving $\frac{Y - C}{1.0p^n - 1} - C$; second, by carrying cost of planting, C, as any other incidental expense for this rotation up to the year n before capitalizing it, giving $C(1.0p)^n$ which with Y then becomes

$$\frac{Y - C(1.0p)^n}{1.0p^n - 1}$$

The expression $\frac{C(1.0p)^n}{1.0p^n - 1} = C + \frac{C}{1.0p^n - 1}$ (§ 57—VIII)

Adding the annual expense capitalized as $\frac{e}{.0p} = E$, the capital value of soil S_v, becomes

$$S_v = \frac{Y - C}{1.0p^n - 1} - (C + E)$$
$$= \frac{Y - C(1.0p)^n}{1.0p^n - 1} - E$$

e. g. In the example cited in § 94 the value of the crop is $400.00 per acre, and the cost of planting is $15.00. Annual expenses capitalized at 5 per cent are $\frac{.30}{.05} = \$6.00$. Then the soil capital value is

$$S_v = \frac{400.00 - 15.00}{1.05^{50} - 1} - (15.00 + 6.00)$$
$$= \frac{383.00}{11.4674 - 1} - 21.00$$
$$= 36.78 - 21.00$$
$$= \$15.78$$

Solving this by the second form

$$S_v = \frac{400.00 - 15.00(11.4674)}{11.4674 - 1} - 6.00$$

$$= \frac{227.99}{10.4674} - 6.00$$

$$= 21.78 - 6.00$$

$$= \$15.78$$

When incidental items are added and a complete appraisal is made of probable cost and income, the item C may be treated in either of the above ways. In the example below, the second method is used.

The final net yield is then worth $\frac{Y - C(1.0p)^n}{1.0p^n - 1}$

The cost of cleaning at d years is: $\frac{C_d(1.0p)^{n-d}}{1.0p^n - 1}$

The first thinning at t_1 years is: $\frac{Th_1(1.0p)^{n-t_1}}{1.0p^n - 1}$

The second thinning at t_2 years is: $\frac{Th_2(1.0p)^{n-t_2}}{1.0p^n - 1}$

The annual expense is: $\frac{e}{.0p}$

The capital value of soil is:

$$S_v = \frac{\left\{ \begin{array}{l} Y - C(1.0p)^n - C_d(1.0p)^{n-d} + \\ Th_1(1.0p)^{n-t_1} + Th_2(1.0p)^{n-t_2} \end{array} \right.}{1.0p^n - 1} - \frac{e}{.0p}$$

E. g. In the above problem with values as given previously, the capital value of the bare soil, if it can be planted immediately and requires 50 years to produce the crop, is:

$$S_v = \frac{\left\{ \begin{array}{l} 400.00 - 15.00(1.05)^{50} - 8.00(1.05)^{50-5} + \\ 25.00(1.05)^{50-30} + 50.00(1.05)^{50-40} \end{array} \right.}{1.05^{50} - 1} - \frac{.30}{.05}$$

$$= \frac{\left\{ \begin{array}{l} 400.00 - 15.00(11.4674) - 8.00(8.9850) \\ + 25.00(2.6533) + 50.00(1.6289) \end{array} \right.}{10.4674} - 6.00$$

$$= \frac{400.00 - 172.01 - 71.88 + 66.33 + 81.43}{10.4674} - 6.00$$

$$= \frac{303.87}{10.4674} = 6.00$$

$$= 29.03 - 6.00$$

$$= \$23.03$$

Capital values for forest property are also called expectation values in that they depend, as do all appraisals of every kind of capital value, on the expectation of future net income, discounted.

The effect of the choice of the rate of interest is easily demonstrated by appraising the capital value of soil for the same expected income as above, but with a different rate.

The capital value of bare soil in the year of planting, in the above problem, at different rates of interest, is:

Rate of discount, per cent	Soil Capital value—dollars
4	$53.98
4½	36.22
5	23.03
5½	13.10
6	4.52

At 6½ per cent or over, the capital value of the soil becomes negative, which indicates that the income is insufficient to pay 6½ per cent compound interest on the remaining capital investments represented by costs of operation, hence there is no margin left by this rate to be discounted as net income on the investment represented by soil.

CHAPTER XI

MARKET VALUES OF FOREST PROPERTY

96. Purchase Areas. — In purchasing forest property either as a single parcel or in considerable areas it is usually necessary to assemble a number of smaller holdings into a forest of size adapted to economical and efficient management. In every such case, the preliminary step is to outline a suitable boundary for the area as the future owner hopes it will ultimately be constituted, and then to confine all purchase as far as possible within this boundary. In public acquisition these are known as purchase areas. These boundaries may be altered when new circumstances dictate such a change. The advantages of a consolidated area are reduction of the boundaries, better protection of the property, greater efficiency of administration at less cost, and better control over use of the property and of its resources. All expenses are reduced, which results in greater value per acre of a consolidated tract over a number of scattered parcels of equal total area. The process of consolidation thus adds to the value of forest lands.

The drawback to creating such purchase areas is that unless the intention is concealed during the process of acquisition it advertises the purchaser's presumptive need for the lands and strengthens the position of those in possession. For a single purchase area, the only effective opposing force on the part of the purchaser is delay. The ability to out-wait the owner keeps prices to a reasonable level. The establishment of several purchase areas brings into play the still more effective force of competition among sellers. Purchases are made where land is offered at attractive prices and reluctant owners can hold the land and pay taxes until such time as they are willing to sell at fair value.

Forced public purchases of specific tracts would totally deprive the public of monopoly strength (§ 28) and lead to exorbitant prices except for the power of condemnation which inherently rests in the state and may be granted by the legislature for the acquisition of lands for definite public uses. In Pennsylvania and New York this power has been granted for the acquisition of state forests. It is more commonly used in acquiring park property. The price fixed by condemnation proceedings is based on an

appraisal which seeks to establish a fair market value for the property.

97. **The Basis of Market Values.** — Market value must be accepted as the proper basis of purchase or sale of property, regardless of either its appraised cost value or its appraised use or capital value. Market value is the exchange or sale value of the property which is what it would sell for in the open market, the seller being under no compulsion to sell, and the purchaser not forced to buy. Another way of stating this is to say that the relative monopoly strength of the two parties is nearly equal (§ 31). Market values are frequently created where for the given commodity this relative balance is unequal and remains so for long periods. Every sale, regardless of the underlying reasons for the price, has a definite influence on subsequent sales of similar property, and this tends to establish market values. If such prices are due to forced conditions they have less effect than otherwise provided such facts are generally known. In theory, market value should be free from the influence of inequality of strength, ignorance of value and over-eagerness to buy or sell, but in fact actual sales are its only criterion in the long run.

As distinguished from individual sales, market value represents the consensus of public opinion as to values. As set forth in § 26, value is the expression in terms of money of the relative strength of the tension between the two great social forces representing on the one hand producers or sellers, and on the other consumers or buyers. Each sale is a test or measure of these relative forces. The relation between individual sales and market values is reciprocal. Every sale has its proportionate influence in establishing market value, and each sale in turn is determined largely by the market value already established. Actual sales, then, are the strongest evidence of market value, whether or not the apparent use value or possibility of income is in agreement with these prices.

There is much misunderstanding of this principle in the purchase of lands. *Appraised use value or capital value is not equivalent to market value.* Capital value is an appraisal by a purchaser (§§ 90 and 27), and its purpose is to inform him, by discounting the prospective value of the income, as to the highest price he can pay for the property to barely earn interest on his capital. To pay this price would deprive him of any possibility of future prospective gain in owning and developing the property (§ 46). Even

the general public may be skeptical, seeing only the risks, unwilling to recognize or capitalize the income at a high present value nor pay such a price for the land. The prospective purchaser should be the last to do so and thus hand over the reward of his foresight and courage in a pioneer field to the present owner who is selling to escape the responsibilities of development. No matter how great the appraised use value of forest property may be for forest production, the *purchaser should not be the one to admit this value as the basis for his purchase price.* That is for the owner to demonstrate and for the public to confirm through market values. When new values, based on actual possibility of realizing income, have become generally accepted in the public mind, these values will be admitted as an element in establishing market prices, and higher prices based on resultant competition will be forced on reluctant purchasers.

98. Appraisal of Market Values. — An appraisal of market values for forest property differs from either a cost value or use value appraisal. Its purpose is to arrive at a fair value as a guide to reaching an agreement on price. A seller's personal appraisal of market value will indicate to him privately the lowest market price at which he should sell. This is *not his cost value.* Similarly a purchaser's appraisal of market value will indicate to him the highest market price which he is justified in paying. This is *not his use value.* As an instance of the former, we have the appraisals of stumpage prices for timber on the National Forests. These appraisals set the minimum price below which the U. S. Forest Service *will not sell at all.* The timber is then advertised and competition among buyers determine whether the true market value is higher than this, or lower, in which case no sale results.

In an appraisal for purchase, the elements to be considered are those which tend to indicate the existing market value for similar property, more than which the purchaser should not pay unless he is forced to possess the property at a sacrifice.

Two factors make it difficult to determine this value. First, sales of land are comparatively infrequent, hence are a less reliable guide to present potential market value than in the case of products. Second, lands differ in quality, hence prices if they are to serve as indicators must be for lands of similar qualities or possessing similar elements of value. For his own information, and not at all in order to indicate the actual market value of the property

as a whole, a prospective purchaser may attempt to classify the elements of value of a given tract of land by physical examination. He can then check the market price offered for the property as a whole by placing on each separate element a tentative value based on the prices that similar property commands in the vicinity, or what other purchasers are offering or would offer for such property or such elements of value.

The elements in forest property which may contribute to its market value are

1. Land, measured in horizontal area.
2. Merchantable timber.
3. Young timber, not now merchantable.
4. Improvements.
5. Other values not connected with forest uses, such as minerals, grazing or agriculture.
6. Recreational or hunting and fishing values.

Some of these elements may have no effect whatever on market value, and will not have unless and until the average purchaser of similar property buys it with the intention of deriving value from this element and is willing to pay for this value. The exceptional purchaser, or the pioneer in a new enterprise, does not or should not be the one to create this market value, for it is only by the divergence between his own appraised use value and the general market value that he has any hope of reward for undertaking the unusual hazards of a new venture (§ 72).

The divergence between appraised market values and use values is apt to be conspicuous in the case of young timber and of forest land. Purchasers of tracts containing merchantable timber have seldom considered the land as of any value whatever, and have based their price upon that of the timber alone. This fact is the controlling influence in market value of such lands. Again, in most regions of cutover lands, young growth until it attains considerable size has not been recognized as having any sale value and has not influenced the price of such lands. As long as market price, which means general public opinion, remains on this basis, such lands should be appraised for purchase on the basis of this opinion alone, disregrading any higher value to the purchaser which may be indicated by the appraisal of use value. When owners uniformly refuse to sell such tracts for the same price as

lands that are not stocked, and can find purchasers who are willing to recognize such values, these values will come to be recognized on the market and added to sale values, as has happened in Southern pine in some regions.

99. The Market Value of Land. — The market value of land is determined almost entirely by the general opinion in the locality as to the most profitable use to which that land is adapted, and the demand which exists for land for this general purpose. It may be regarded by the public in general as absolute forest land, grazing land, or farm land, actual or potential. It is usually impossible to avoid including small areas of farm land with some purchases of forest land.

If sales of bare land of similar quality have occurred in the vicinity, these prices will be taken as a guide for appraisal. Such sales can usually be found for farm or grazing lands. The value of farm lands depends on the demand in the neighborhood for such lands to be used as farms, and this in turn upon whether the community is prosperous or decadent. In the latter case, especially when farms are being abandoned, prices through lack of buyers are comparatively low. Such abandoned farm land should not exceed the value of forest soil of similar quality.

Suburban or residential estate values appear in regions of growing and expanding urban populations. These values may establish the market value of lands on a level which prohibits their purchase for forestry at reasonable prices and may even exceed the use value of the property for this purpose. Grazing use may contribute to the value of forest land on the market, entirely independent of any question of its effect on the forest growth.

The demand by private capital for forest land for the purpose of growing timber exists as yet only to a very limited extent and has had almost no effect on market values. On the other hand, the market for mature standing timber is universal and active, resulting in the establishment of market values for forest property containing such timber.

The economic worth of land must not be confused with its market value, although in final analysis market value rests on this economic basis of use and will be largely determined by income. The question of land classification or the policy of devoting land to forest production, especially when it involves public purchases, must be settled on the general basis of public economy based on

experience in past use, public needs and public benefits. With private ownership, each owner decides this use for himself. In either case, once the decision has been made to purchase land for forest purposes, *the intention of the purchaser should affect market value not at all,* and is only of importance in aiding him to decide whether the values offered enable him to buy advantageously, or in enabling an informed owner to take advantage of a purchaser's need or desire if not reinforced by the ability to wait or choose.

As an aid to the prospective purchaser in appraising, not the use value, but a fair market value, thus enabling him to decide on what price to offer the owner, forest land may be separated into standard qualities of site based on productivity of the soil for tree growth. Five site qualities have recently been standardized by foresters in the southern Appalachians, based on height of dominant trees in mature stands, or in absence of such trees, on the relative rate of height growth of young trees. Barren land incapable of producing timber should be separately listed and burns classified on the basis of the severity of the damage gauged by the length of time it will take to secure reproduction, e. g., in an appraisal on the Allegheny plateau in Pennsylvania the basis or standard soil values were discounted as follows:

Character of burn	Time required to restock Years	Reduction in prices per cent
Light	3	10
Medium	6	25
Severe	10	45
Very severe	15	65

100. The Market Value of Merchantable Timber. — Since the market value of forest land is almost wholly dependent on that of the merchantable timber it contains, determination by field examination of the quantity, quality, and relative location of the merchantable products on the area is indispensable in appraising this market value. On the basis of a complete inventory of timber the market value can be appraised with fairness, and not otherwise.*

The elements affecting the market price of standing timber are:

1. Cost of transportation, or the relative accessibility of the timber. Species for which no market exists or whose value

*For methods of conducting a timber survey, see Chapman's Forest Mensuration, Chapters XIX-XXI. John Wiley & Sons, N. Y.

on the stump is less than the cost of getting the product to market cannot be included in value (§ 146).

2. Character of local markets. This is greatly improved by the presence of wood-working industries.
3. Prospective road construction which will cheapen transportation.
4. State of the community, and employment of farm labor in the woods in winter.
5. Competition of private buyers who want timber for immediate operation.
6. Period for which timber must be carried as an investment before operating.
7. Difference in value of an assembled tract and its various components.

The first four of these factors are outstanding influences affecting the margin between the price of forest products and the cost of logging and manufacture, which margin largely determines the stumpage values. Where these costs for a given species exceed the market value of its products it can have no value on the stump (1). Local wood-working industries raise values by making an intensive use of the wood output, producing articles of comparatively high value, and creating an ample margin for stumpage (2). Cheapened transportation enlarges this margin by reducing costs (3). Where a community holds timber largely as woodlots, an intensive local market is thus created, adding to the desirability and hence the value of such property (4).

The value of stumpage for immediate cutting is a maximum value for standing timber (5). This is commonly termed a *royalty value* or operating value and applies to purchases in which payment is made currently either just in advance of or subsequent to cutting. The purchaser does not have to own or carry the timber. He is saved the following costs: taxes, fire protection and administration, insurance, losses of timber from any cause, loss of interest on his investment, and the cost of purchasing and assembling the land (§ 139). Consequently, buyers who want timber in quantities capable of being cut and moved in a short period can pay a higher price than is justified for permanent ownership, and if a purchaser meets such competition he may be forced to recognize the effect on the market price or be unable to buy this timber at all.

Items 6 and 7 are universally recognized as decisive elements in market values of merchantable timber. The postponement of final income from operations requires the purchaser to discount operating stumpage values in order to enable him to realize an adequate interest return on his purchase after paying taxes and other annual expenses and incurring the various physical hazards illustrated by fire, spruce bud worm or other possibilities.

The price at which an assembled tract will sell to a purchaser, said tract being large enough to constitute the basis for an operation of efficient size for the region, has seldom if ever exceeded two-thirds of the current price of stumpage for immediate operation, or on the royalty basis. The average price of such purchases is approximately one-half of this operating value. Neglect of this fact in appraisals, and the basing of a purchase price on an appraisal of stumpage for immediate cutting (chapters XV and XVI) would place the purchaser in a position where the realization of profits from operation would be next to impossible (7).

Where a tract is being assembled by purchasing its component holdings which may be small and numerous, the cost of purchase and assembly constitutes a further deduction from values. The maximum unit price per acre should be that which a single purchaser would pay for an assembled tract, as above set forth. From this the average cost of assembling must be deducted. These costs may run from 5 to 20 per cent of the total expense of purchase, depending largely on the size of the unit, the character of the surveys, and the condition of the titles.

Allowing 50 per cent of operating value of stumpage as the price for purchase of an assembled tract, 20 per cent of this as an allowance for cost of assembling would be $.20 \times .50 = .10$ or 10 per cent of stumpage value, indicating that on this basis for individual tracts the purchase price should not exceed 40 per cent of the current stumpage value of timber for immediate operation, exclusive of land value.

101. **The Market Value of Young Timber.** — Unless the value of unmerchantable young timber or of species not now merchantable has already been recognized in sales, it must not be considered in appraising market value of forest property, for the reason given in § 98. Even when recognized, the value is seldom separately considered but is included in that of forest land,

properties well stocked with young timber commanding a slightly higher price than if bare of reproduction.

Where these values are publicly recognized, and yet there exists no sufficient basis in establishing market prices to permit of a valid appraisal on that basis, recourse may be had to tentative appraisals of use value or capital value, basing this value, however, on the shortest rotation that will produce merchantable timber, and using a rate of discount sufficiently high to represent the existing attitude towards fire and other hazards, and to protect the purchaser (§ 98). For this purpose the purchaser may employ the standard method of discounting the crop value by the formula

$$V_0 = \frac{Y - \left(S + \frac{e}{.0p}\right)(1.0p^n - 1)}{1.0p^n}$$

in which n is the period previous to maturity, S is the appraised value of the soil, e the annual expense, and V_0 the value of the timber exclusive of soil value. A rate of at least 5 to 6 per cent is advocated in such an appraisal.

In appraising young timber, height and density of stocking should be the criterion of value. Stands less than 20 feet in height and less than 25 per cent stocked seldom affect land value unless artificially planted and in very advanced regions of forestry practice.

102. **The Market Value of Improvements.** — The value of any improvements which exist on property to be appraised will depend wholly on whether these have a future use in connection with the objectives for which the property is being acquired. Abandoned farm buildings are usually valueless unless they can be used to house permanent employees such as forest rangers or guards, or will bring in a revenue in connection with the uses sufficient to cover upkeep, interest on cost and general forest overhead. On the other hand, improvements which directly serve the purpose of the forest must be valued on a fair basis, preferably cost of replacement less depreciation.

103. **Other Market Values.** — Recreational use and fishing and hunting have a market value whenever these uses are a source of definite income to the owner, the latter through stocking and expense in development. Where such values reach large proportions they cannot be recognized for forest purchase and will pre-

clude such purchases. The value for watershed protection is not an element in market value of property.

A nuisance depresses the value of adjoining property and its removal increases this value. For this reason, prices are frequently paid for property which its own value does not justify, but which represent, instead, an effort to protect or restore adjoining values. This gives rise to the term "nuisance value." Such nuisances should, when possible, be controlled by law rather than by purchase.

The value of rights of way will serve to increase the price which a purchaser can afford to pay and should be based on a percentage of the net profit over cost of purchase and holding timber, which can be realized from its sale or operation.

104. The Market Value of Forest Property. — Since the object of an appraisal of market value by a purchaser is to indicate the highest market price which he can afford to consider in buying property, the purchase should, if possible, be consummated at a price below this appraisal, especially if the lower price is indicated by previous or contemporary sales. To an owner, the reverse is the case.

In final analysis, the market value of forest property is the price at which sales can be negotiated in volume sufficient to supply the existing demand. No other criterion is possible (§ 31).

CHAPTER XII

THE RATE EARNED BY FOREST INVESTMENTS

105. The Rate Earned Annually. — For comparison, rates earned on all investments are reduced to an annual equivalent. The use of compound interest formulae are intended to accomplish this in case of deferred returns.

Rates are either based on actual earnings as in case of a completed transaction, or on appraisals of future earnings and costs, giving an estimate of future net operating income. The rate actually earned in any year is found as follows (§ 49):

$x =$ rate earned
$P =$ profit for year, and
$I =$ capital investment or cost.

$$x = \frac{P}{I} 100$$

For a forest which is a going concern (§ 60) managed on the principle of a sustained yield, the rate earned is based on the investment in land and timber, $S + T$, and working capital equivalent to $C + ee$. The net income annually is equal to $Y + Th - (C + ee)$,

Then
$$x = \frac{Y + Th - (C + ee)}{S + T + C + ee} 100$$

e. g. Referring to the problem in § 86 the net income from this forest is \$600.00 — 175.00 = \$425.00. The capital invested in land and timber is \$5,000 and working capital is \$175.00.

Then
$$x = \frac{425.00}{5175.00} 100$$
$$= 8.21 \text{ per cent.}$$

This indicates that the purchase price was below the true value of the property unless 8 per cent is the return expected by investors.

In §§ 47-48 it is shown why a rate earned annually, based on actual income and expense, is not always dependable as a true indication of the earning power of the forest.

106. The Rate Earned over Periods of Deferred Returns. — *The Indicating Per Cent.* This rate earned may be sought

for a short period in the immediate future, the purpose being to indicate the present condition of the stand as an investment by comparing such rate with the rate desired or thought to justify retaining the stand for future growth. Such a rate is called the Indicating Per Cent. In determining this per cent, the factors of future increase in volume of stand, quality of product and unit price are all included (§ 40).

For any period, if the conditions are such that the initial investment can be compared directly with the value at the end of the period, the rate earned x may be readily found by the formula

$$1.0x^n = \frac{V_n}{I} = \frac{P+I}{I} \qquad (\S\ 49)$$

This equation is solved by logarithms—

$$\log.\ 1.0x = \log.\frac{V_n}{I} \div n.$$

Actually these conditions seldom apply. During any period n, annual expenditures are certain to occur, and both irregular expense and irregular income may have to be reckoned with. Each outlay of cash in absence of net operating income must be added to the capital investment (§ 87), hence from the year of its expenditure is entitled to share in the rate earned. Each item of income correspondingly cuts down this capital investment and reduces the total on which the rate is computed. The result is that the value x will appear on both sides of the above equation and make its direct solution impossible.

One method of simplifying the problem is to assume a fixed rate p as interest on all expenses occurring during the period, and to deduct this sum with interest from the final value V_n before determining the rate earned on the remaining investment, which is thus confined to the initial capital S and T or C.

This resembles the process of borrowing a part of the capital, represented by annual operating costs, at p per cent, thus excluding this interest from the owner's profit. Such procedure does not give the true economic rate earned by the total capital investment (§ 22). Where the period is short, and the item of annual expenses is relatively small compared with the remaining investment, this error may be overlooked in an appraisal of the approximate rate earned.

Let V_n = value of property at end of period including net income received.

I = cost, or initial investment including land, S, timber, T, and cost of establishment, C, if any.

x = rate earned.

e = annual expenses.

$E = \frac{e}{.0p}$ or capitalized expenses at p per cent.

Then
$$I(1.0x)^n + E(1.0p^n - 1) = V_n$$
$$1.0x^n = \frac{V_n - E(1.0p^n - 1)}{I}$$
$$1.0x = \sqrt[n]{\frac{V_n - E(1.0p^n - 1)}{I}}$$
$$\log. 1.0x = \log. \frac{V_n - E(1.0p^n - 1)}{I} \div n$$
$$x = (1.0x - 1)100.$$

E. g. A stand of timber yielding 10,000 board feet per acre was purchased 10 years ago for $50.00 per acre. The timber is now worth $10.00 per thousand board feet on the stump, or $100.00 per acre. Annual expense has been 30 cents per acre. The land is valued at $5.00 per acre. The expenses are reckoned at 5 per cent interest.

Then
$$1.0x^{10} = \frac{100.00 + 5.00 - \frac{.30}{.05}(1.05^{10} - 1)}{50.00}$$
$$= \frac{105.00 - 3.77}{50.00} = 2.0246$$
$$\log. 1.0x = \log. 2.0246 \div 10. = .030694$$
$$1.0x = 1.073 \qquad x = 7.3 \text{ per cent}$$

Opportunities to make profits of this sort which include a fair entrepreneur's gain arise from lack of appreciation by owners of the actual potential value of second growth pine timber. Even larger profits have been realized in such regions as the southern pine belt on young stands if bought at the right age and price.

The substitution of the Pressler formula in this problem, i. e.

$$x = \frac{V_n - I_0}{V_n + I_0}\left(\frac{200}{n}\right) \quad \text{taking } V_n = 105.00 - 3.77, \text{ gives}$$

$$x = \frac{101.23 - 50.00}{101.23 + 50.00}\left(\frac{200}{10}\right) \quad (\S\ 49)$$

$$= 6.77 \text{ per cent}$$

This formula expresses the result in simple interest by increasing the capital on which this rate is computed to $\frac{V_n + I_0}{2}$ or the average invested value, which in this example is $75.62.

The per cent as found by the Pressler formula is always less than the true rate of compound interest, and the discrepancy increases both with the increase in rate earned and with the length of the period. For 3 per cent and 50 years, the Pressler rate is 2.5 per cent, while for 100 years the latter formula gives but 1.8 per cent. For rates of 5 per cent or less, and for intervals not exceeding 20 years, the results agree closely. The only advantage of the Pressler method is in avoiding the use of logarithms.

107. The Rate Earned by a Timber Crop. — *The Mean Annual Forest Per Cent.* These principles of determining the rate earned, x, may be applied to periods of any length, and to entire forests, to a portion of a forest, or to a single stand either for a current period or throughout its entire life. Accounts determine past rates x actually earned. Appraisals indicate probable future rate, x, to be expected.

The rate of compound interest earned by a forest crop over the entire crop period from establishment to final cutting has been termed the *mean annual forest per cent.* In determining this rate, x, it will no longer be advisable to adopt the device of a theoretical borrowing of part of the capital in order to eliminate the quantity x from all but the initial investment. Borrowing is a private bargain between capitalists as to both the proportion of the total capital that is to be raised by such methods and the rate of interest to be guaranteed by the borrower. The purpose of ascertaining x is to find the rate earned by the entire capital investment required in the enterprise, leaving its division to the judgment of the entrepreneur. With the introduction of x in several values in the

equation, its solution rests on a choice of two methods, trial and error, or the use of a graph.*

108. Method of Trial and Error. — By the method of trial and error the ratio of earnings to investment, or $\frac{V_n}{I}$ (§ 106), is first approximated. A per cent is then adopted as near to the ratio earned as possible. By inspection of the ratios given in the compound interest tables for different per cents, for the period of years required, this trial per cent may be chosen.

Using this value of p, the equation is solved by logarithms for $1.0x$.

The value of x so found is then substituted for the original value of p for quantities on the right of the equation and a second solution for the value for $1.0x$ is worked. This will more closely approximate the rate earned. If the original value p is not too divergent from x, this second operation usually brings the solution to within 1/10th of 1 per cent. If not, a third solution will do so. Practical agreement between successive results indicates that the correct value of x has been found.

The simplest application of this method is to a case (§ 106) in which the only items of investment are the initial cost plus annual expenses. Since the true value of x is to be found, $E = \frac{e}{.0x}$ and $I(1.0x^n) + \frac{e}{.0x}(1.0x^n - 1) = V_n$; or simplifying and transferring $\frac{e}{.0x}$

$$\left(I + \frac{e}{.0x}\right) 1.0x^n = V_n + \frac{e}{.0x}$$

$$\log.\ 1.0x = \log.\left(\frac{V_n + \frac{e}{.0x}}{I + \frac{e}{.0x}}\right) \div n$$

* The first of these methods, as well as the description of the derivation of the rate x, appeared in the first edition of Chapman's Forest Valuation, 1914. The second method, and the use of the term Mean Annual Forest Per Cent, appeared in England, in the Quarterly Journal of Forestry for July, 1919, by W. E. Hiley, M.A., and in 1922 and 1925, in Volumes I, 4th edition, and III, 5th edition, Manual of Forestry, by Sir William Schlich, and in a pamphlet by Dr. Schlich published in 1904, "Forestry in the United Kingdom," reference to which was omitted in earlier editions of his manual.

e. g. A plantation of white pine on land costing $10.00 per acre is made for $15.00 per acre. Taxes and protection costs 30 cents per acre. The final yield of 40,000 board feet at 50 years is valued at $400.00. Land remains at $10.00. Then $V_n = \$410.00$.

The trial rate may be approximated by neglecting the sum of the annual expenses and comparing the initial investment directly with final value to obtain the ratio, e. g.

$$\frac{410.00}{10.00 + 15.00} = 16.4$$

This is for 50 years. In the compound interest tables, opposite 5½ per cent the ratio is 14.54. For 6 per cent it is 18.42. A trial per cent can then be chosen of 5¾. Capitalizing $\frac{e}{.0x}$ as $\frac{.30}{.0575}$ gives $5.22 as the working capital required.

Then $$\log. 1.0x = \log. \frac{410.00 + 5.22}{10.00 + 15.00 + 5.22} \div 50$$

$$= \log. \frac{13.739}{50} = \frac{1.37956}{50} = .02759 \quad .022759$$

$$1.0x = 1.0654 \; 1.0538 \qquad x = 6.54 \; 5.38 \text{ per cent}$$

Substituting 6.54 5.38 for x, $\frac{e}{.0x} = 4.59 \; 5.57$

$$\log. 1.0x = \log. \frac{410.00 + 4.59 \; 5.57}{10.00 + 15.00 + 4.59 \; 5.57} \div 50$$

$$= \frac{\log. 14.011 \; 15.574}{50} = \frac{1.14648 \; 1.33347}{50} = .029294 \; .022666$$

$$1.0x = 1.0695 \; 1.0536 \qquad x = 6.95 \; 5.36 \text{ per cent}$$

In the third trial $x = 7.1$ per cent
fourth $x = 7.25$
fifth $x = 7.29$

The true value of x is evidently about 7.3 5.35 per cent.

Taxes have not been increased in this example, nor has a yield tax been levied. The true earnings will therefore be less than this rate when all items are properly appraised.

To determine the true mean annual forest per cent earned by a crop of timber, every item of cost or income must be included

(§ 89). The credit items or income are final crop Y, thinnings Th, and land S_o. The value at n years is

$$Y + Th_1(1.0x)^{n-t_1} + Th_2(1.0x)^{n-t_2} + S_o$$

To balance this income, the investment at x per cent is:

$$S_o(1.0x)^n + C(1.0x)^n + C_d(1.0x)^{n-d} + \frac{e}{.0x}(1.0x^n - 1)$$

The expression $\frac{e}{.0x}(1.0x^n - 1)$ is treated as in the first example, and the last term shifted to the side of income or assets.

Then:

$$S_o(1.0x)^n + C(1.0x)^n + C_d(1.0x)^{n-d} + \frac{e}{.0x}(1.0x)^n =$$
$$Y + Th_1(1.0x)^{n-t_1} + Th_2(1.0x)^{n-t_2} + S_o + \frac{e}{.0x}$$

A trial value p found as in the preceding case must now be substituted for x in the expressions $Th_1(1.0p)^{n-t_1}$ and $Th_2(1.0p)^{n-t_2}$ and these values found for the year n and added to Y. In the same way, the value of $C_d(1.0p)^{n-d}$ is treated as $\frac{C_d}{1.0p^d}(1.0x)^n$ and $\frac{C_d}{1.0p^d}$ is discounted to the year 0 and added to C. The value of $\frac{e}{.0x}$ is found as $\frac{e}{.0p}$

The equation can then be reduced to the form

$$1.0x^n = \frac{Y + Th_1(1.0p)^{n-t_1} + Th_2(1.0p)^{n-t_2} + S_o + \frac{e}{.0p}}{S_o + C + \frac{C_d}{1.0p^d} + \frac{e}{.0p}}$$

Solving by logarithms or by approximation from inspection of the compound interest tables for n years, the new value of x is found. This value is then substituted in the above equation, on the right, and the process repeated.

E. g. The plantation of white pine above described requires a weeding expense of $8.00 at 5 years. Thinnings at 30 years yield $25.00 and at 40 years, $50.00. From the final value of the crop a yield tax of 10 per cent is deducted, giving net final income of $360.00.

In seeking a trial ratio of earnings to investment the item of

annual expenses is omitted as usual. The ratio for this 50 year period would then be

$$\frac{360.00 + 25.00 + 50.00}{10.00 + 15.00 + 8.00} = \frac{435.00}{33.00} = 13.18$$

This indicates that x is between 5 and 5½ per cent. Adopting 5 per cent and obtaining the values of Th_1, Th_2 and C_d we have

$$1.0x^{50} = \frac{360.00 + 25.00(1.05^{20}) + 50.00(1.05^{10}) + 10.00 + \frac{.30}{.05}}{10.00 + 15.00 + \frac{8.00}{1.05^5} + \frac{.30}{.05}}$$

$$= \frac{523.77}{37.26} = 14.057$$

$$\log. 1.0x = \log. 14.057 \div 50 = .022958$$

$$1.0x = 1.0543 \qquad x = 5.43 \text{ per cent}$$

Substituting 5.43 for 5 on the right and solving again for x

$$1.0x^{50} = \frac{360.00 + 25.00(2.8785) + 50.00(1.6965) + 10.00 + \frac{.30}{.0543}}{10.00 + 15.00 + \frac{8.00}{1.3025} + \frac{.30}{.0543}}$$

$$= \frac{360.00 + 71.96 + 84.82 + 10.00 + 5.52}{10.00 + 15.00 + 6.14 + 5.52}$$

$$= \frac{532.30}{36.66} = 14.5199$$

$$\log. 1.0x = \log. 14.5199 \div 50 = .023239$$

$$1.0x = 1.05497 \qquad x = 5.5 \text{ per cent}$$

The rate x serves to just equalize the cost or investment, I, which includes S, C and E, with the final value of capital and income V_n. It is assumed that land does not increase in value. If this increase does take place it adds to the profit and to the rate earned for the past period. This additional profit comes not from operating earnings at x per cent, but from "unearned increment" or the capitalizing of subsequent future earnings at a rate less than x per cent, reflected in increased market values.

If the true rate x is found which is earned from net operating income, it is assumed that *the same rate can again be earned* by the next crop. If on the other hand, the property increases in market value, this signifies that the future *rate* earned on the same income

will be smaller, and that the increase in the present rate x from this source of profit is due to a capitalizing of the future profits at the lesser rate.

109. **Method of Charting the Per Cent Curve.** — It is evident that the rate x sought is the one which coincides exactly with the ratio between future value and present value or between value and cost, so that if this rate is used to compute interest, the equation between cost and value will be balanced, as

$$I(1.0x)^n = V_n, \quad \text{or} \quad \frac{V_n}{1.0x^n} = I.$$

It was also seen (§ 95) that when any given per cent p was used to capitalize future net income for the moment or year when the soil was bare and all costs of production in the future had been consequently deducted from value, the soil value thus found was the residual value which balanced the equation, and that with each different value of p this residual soil value differed.

These facts now permit of a very simple determination of the rate x which will balance a given equation in which the soil value is taken as equal to the cost of the soil and is a fixed quantity. The method consists in determining, for a definite set of items of income and expense, the capital value which soil would have if different rates p were used. One of these soil values so found will of course be the price actually paid for the land, and for this one value the rate which gives it is the rate x sought which is earned by the entire investment, since all the other items were discounted by this rate to get this specific soil value. If for instance \$10.00 is paid for land and at 5 per cent the soil value is \$19.21, while at 5½ per cent it is \$10.14, the rate earned evidently is very close to 5½ per cent.

Instead of interpolating between the nearest ½ per cents by new solutions at trial rates, it is better to plot the respective rates earned for different soil values or prices, and produce a graph or curve from which the rate earned for any given soil value or cost can be read directly. An example of such a curve for the rotation of 50 years, and the above problem, is given in Fig. IX.

For each different set of items or problem, and for each rotation, curves can thus be drawn exhibiting the range of possible rates, x, which may be expected on the basis of the price paid for land.

These principles apply equally well to any other investment or period and permit the rate earned, x, to be found under any circumstances. In the case of a forest or a stand of young timber, the rate x is that which will balance the equation between the initial cost and returns, and the curve will be based on the initial investment values found for each of the trial rates x.

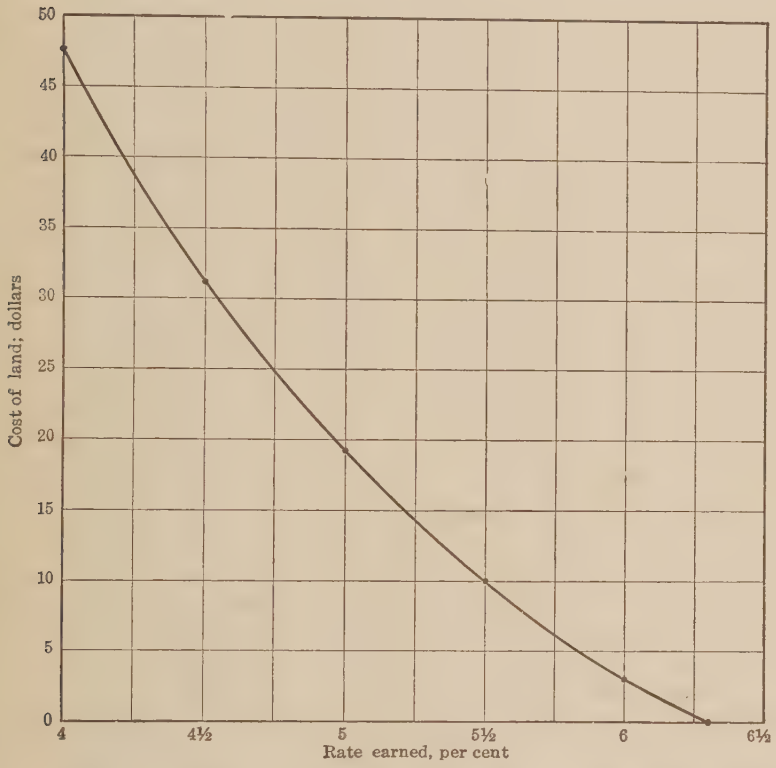


FIG. IX.—Rate earned by white pine plantation on 50 year rotation based on different costs of soil and given income.

The formula for soil capital value is (§ 95)

$$S_v = \frac{\left\{ \begin{array}{l} Y + Th_1(1.0p)^{n-t_1} + Th_2(1.0p)^{n-t_2} - \\ \quad C(1.0p)^n - C_d(1.0p)^{n-d} \end{array} \right.}{1.0p^n - 1} - \frac{e}{.0p}$$

Using the value given in the previous problem and substituting the proper values for a trial rate of 4 per cent, the soil value is:

$$S_v = \frac{\left\{\begin{array}{l} 360.00 + 25.00(2.1911) + 50.00(1.4802) - \\ \quad 15.00(7.1067) - 8.00(5.8412) \end{array}\right.}{6.1067} - 7.50 = \$47.43$$

The capital values (soil values) for other values of x are found to be

Per cent	Soil value
4	47.43
4½	31.24
5	19.21
5½	10.14
6	3.22

Plotting these values, the curve of x per cent may be read, for this income, for any purchase price or cost of land, as shown in Fig. IX.

By computing values for rotations of different lengths, the per cents earned for these rotations may now be plotted on the basis of the age or period, and a curve drawn through points having equal values of x, which will show the rotation which yields the highest mean annual forest per cent for each separate land value. Such a chart is termed the Indicator Graph. An example of this graph is shown in Fig. X.

The mean annual forest per cent is based entirely on the theory of soil rent, not that of forest rent, hence finds its application in the creation of new forests by planting and does not apply to existing stands or going concerns (§§ 67-68).

110. The Rate Earned as a Basis of Appraisals of Young Timber. — The most important application of the mean annual forest per cent or rate earned by a forest investment is its use in appraising the value of single stands of partly grown timber. In appraising damages it frequently becomes necessary to obtain these values either from a cost basis or by capitalizing the expected income.

If the rate earned differs from the per cent p which is used for either cost value or capital value, the resultant value of the young timber thus obtained will not give the owner the proper proportion of his anticipated gain, since the value will be either above or below that obtained by the use of this rate x. If the mean annual forest

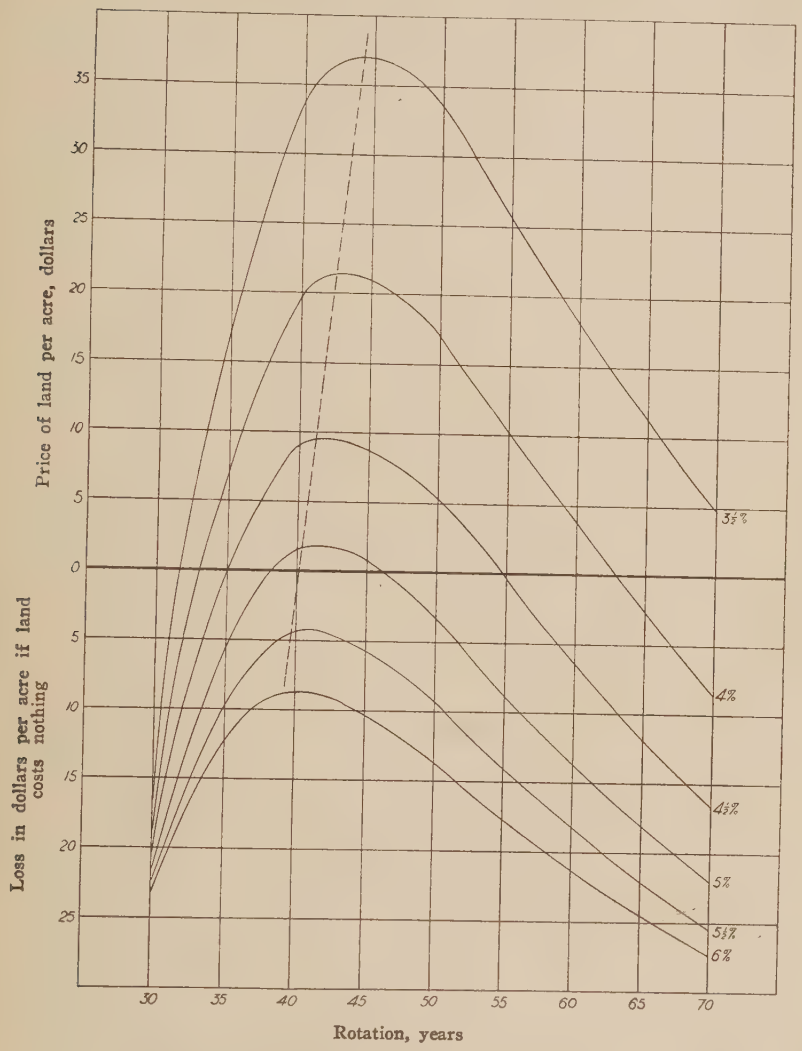


FIG. X.—Indicator graph for white pine plantations in New England, giving the per cent earned for different rotations, based on different costs of land, when income and costs of production are as indicated in footnote. Line – – – indicates culmination of earning power at different per cents.

per cent is used, the cost value for each year in the period will equal the capital value of the same crop for that year. The owner if compensated on this basis will be paid at the rate which he is actually earning and is entitled to receive.

If a lower rate than x is chosen and he settles on a cost value appraisal, the owner obtains less than the crop value, and if his basis is capital value or discount, he obtains more than its value. If the rate chosen for p is higher than x, exactly the opposite results occur and the owner gains if cost value is applied and loses on the basis of discount or capital value. Thus the use of any other rate than x earned by the investment works a hardship on one or the other party to the valuation, and the less informed of the two is apt to get the worst of it. This is especially true when high rates such as 6 per cent of compound interest are admitted irrespective of rate earned or the laws of compound interest.

The effect of introducing a false rate p instead of x is to either increase or decrease the rate realized on the uncompleted enterprise as contrasted with that which was being actually earned previous to the appraisal. Thus by the use of the rate p, a speculative

---

Data on which Indicator Graph, Fig. X, is Based.

Yields, site quality II for white pine, round edge lumber, from Table 27, Forest Mensuration, by the Massachusetts State Forester, 1921.

Age years	Yield, board feet per acre	Stumpage price per M bd. ft., dollars	Value of crop per acre, dollars.
30	12,500	6.00	75 00
35	24,400	7.00	170.80
40	32,800	8.00	262.40
45	40,600	8.50	345.10
50	46,500	9.00	418.50
60	53,200	10.00	532.00
70	59,600*	12.00	715.20

* By extension of curve.

Costs Per Acre

Planting	$17.50
Weeding and tending cost and interest to 10th year	10.00
Protection, annually; for first 25 years	.25
second 25 years	.10

Taxes, annually:

For first 20 years	$ .30	For 41 to 60 years	$3.00
21 to 40 years	1.00	61 to 70 years	8.00

element is introduced into this valuation which should be rigidly excluded. The effects of this process are illustrated by the following example which is purposely simplified by omission of current items of income or of expense.

An investment of $100.00 is made in a young forest which will earn 10 per cent per year compounded, if held for 20 years, bringing in a prospective income at that time of $672.76. After 10

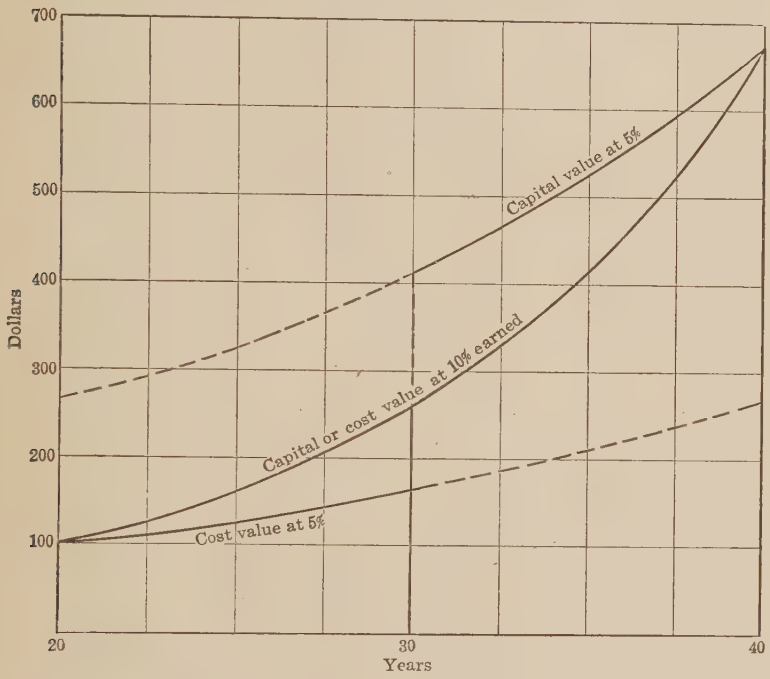


FIG. XI.—Result of appraising value of a stand of young timber at 30 years whose cost at 20 years was $100.00 and whose value at 40 years is appraised at $672.76; by using rate earned x, and by using basic rate of interest p, for cost value and for capital value respectively.

years the property is condemned for public use. On the basis of the rate earned, 10 per cent, its value at that time, is $259.38.

The basic rate (§§ 69 and 80) of interest is at that time around 5 per cent. If the owner has to settle on a cost value appraisal of $100.00 plus 5 per cent, he must take $162.89. If he settles on the basis of the future income discounted, he will receive $413.00. In the first case he loses $96.49 and earns but 5 per cent,

and in the second gains $153.62 on his true value at 10 per cent, which makes the actual rate which he earns in 10 years in this case amount to 15.2 per cent compound interest. In neither case is an equitable value determined.

The rate earned can be computed and tabulated for as many different conditions of income and cost of timber production as are found desirable, or can be easily determined for specific cases whenever it is possible to appraise both actual cost and probable operating income.

By appraising or fixing the value of land at its present market price (§ 120) and adopting this as a constant, i. e. as value applying to both past and future, the rate x and the profit are freed from any speculative element of future increase in land value (§§ 42 and 44) and the value of the crop is separated as a true income.

At n years, soil value S for even-aged stands represents the value of all future crops, or the value of the initial investment remaining intact. These conceptions are interchangeable. The value of the property is therefore $Y + S$.

For any year a, during the growth of the timber crop, the value of this property V_a is

$$V_a = \frac{Y+S}{1.0x^{n-a}} - \frac{e}{.0x}\,\frac{(1.0x^{n-a}-1)}{1.0x^{n-a}}$$

which by reduction and substitution of E for $\frac{e}{.0x}$ becomes

$$V_a = \frac{Y+S+E}{1.0x^{n-a}} - E$$

For the same year, the cost value I_a which is identical, is

$$I_a = \left(S + C + \frac{e}{.0x}\right)1.0x^a - \frac{e}{.0x}$$

or

$$= (S + C + E)1.0x^a - \mathrm{E}$$

To these skeleton formulae may be added the items for incidental income or costs, giving,

For capital value:

$$V_a = \frac{Y + S + E + Th_1(1.0x)^{n-t_1} + Th_2(1.0x)^{n-t_2}}{1.0x^{n-a}} - E$$

For cost value:

$$I_a = (S + C + E)1.0x^a + C_d(1.0x^{a-d}) - E$$

These values include both timber and soil, which can be stated separately by deducting S or cost of soil from total value.

E. g. In the example given in § 109 the income is, net final yield minus tax, $360.00 at 50 years, thinnings $50.00 at 40 years and $25.00 at 30 years. Costs are, land $10.00, planting $15.00, weeding $8.00 at 5 years, annual expenses 30 cents. The rate earned by this stand was found to be 5.5 per cent.

The capital value at 25 years is:

$$V_{25} = \frac{\left\{ \begin{array}{l} 360.00 + 10.00 + \frac{.30}{.055} + 25.00(1.05)^{50-30} + \\ \qquad 50.00(1.05)^{50-40} \end{array} \right.}{1.05^{50-25}} - \frac{.30}{.055}$$

$$= \$134.52$$

The cost value at the same age is:

$$I_{25} = (10.00 + 15.00 + 5.45)1.05^{25} - 8.00(1.05)^{20} - 5.45$$

$$= \$134.01$$

The slight difference between these values is due to the fact that the rate earned differs slightly from 5½ per cent.

111. Entrepreneur's Gain in Forests Investments.—In § 79 it was shown that the entrepreneur's gain could be expressed as the difference between the rate earned x and the basic rate p, for the enterprise (§ 80), but that for compound interest ratios the difference in the per cents x and p were not mathematically equivalent to the same numerical differences in rates of simple interest. Table II, page 92, reveals the extent of these differences, which increase with the rate earned and with the length of the period, so that an entrepreneur's gain of 1 per cent over a basic rate of 6 per cent for a 70 year rotation would represent 53 times as much actual profit as a sum equivalent to 1 per cent compound interest for that period. Hence, neither the basic rate demanded or the actual rate earned, nor finally the entrepreneur's gain, can be compared with the profits of a going concern by comparing the respective interest rates. Ratio of gain, or the simple interest earned for the period, serves as a corrective of these falsely depressed values indicated by rates of interest. But there remains another method of expressing entrepreneur's gain which at least offers a more equitable comparison. In this method, a standard or basic rate of interest is adopted for both cost value and capital value.

The gain is expressed not as a rate of profit but as a difference between these two values for a given year.

The entrepreneur's gain is thus the difference in any year between cost value, which includes all past net cost with interest at p per cent to a given year, and capital value, which discounts all future net income at the same per cent to the same year.

Once this difference, or gain, is determined for any year of the period required to earn it, whether it be a full rotation or a lesser interval, its equivalent value can be found for any other year in the period by using the compound interest or discount ratio for the difference in years. E. g., a gain of $100.00 at 50 years is expressed in the initial year if $p = 5$ as $\frac{\$100.00}{1.05^{50}} = \$8.72$. In the 30th year this gain is discounted by $50 - 30 = 20$ years, or $\frac{\$100.00}{1.05^{20}} = \$37.69$. If a gain of $8.72 is computed for the initial year, and is sought for the 30th year, its equivalent is $\$8.72(1.05)^{30} = \$37.69$.

This relationship holds good throughout an entire period for a given appraisal based on specific assumptions as to income and cost items and as to the basic rate p. For every change in either the rate or any item of cost or income, a different gain or loss will be appraised or predicted. The fact that income may be received at irregular intervals and expense occur in like manner will not change the value of the margin of gain for a given year.

The explanation lies in the fact that the entrepreneur's gain is the sum required to balance an equation, whose sign, $=$, represents the present moment. One member is past cost value, and the other is capital value, discounted from the future.

When a term is transferred from one side of an equation to the other, its sign must be changed. On the one side expressing capital value, income is plus, cost is minus. On the opposite side, cost is plus and income minus. The exact equivalent for any item of cost or income for any year is found for the desired year of the equation by using the uniform rate p to reduce it to that year either by interest for the past or discount for the future.

Consequently, when the desired year is advanced into the future, the future cost items occurring during the interval, now becomes past cost items, are transferred to cost value, and become plus without disturbing the equation. The same is true of future items of income. E. g., if cost value for the 25th year is known, and

income from a thinning is receivable in the 30th year it appears as a future plus item discounted for 5 years. Now if the cost value is wanted for the 35th year, this income item falls in the past, is transferred to cost value, becomes negative, diminishing cost value, and interest for 5 years is also deducted from costs to bring the reckoning from the 30th to the 35th year. On this basis, when the difference G which balances the equation is found for any year, the same difference after it is corrected for *time,* by compound interest or discount, will balance the equation for any other year. Entrepreneur's gain may then be shown on a p per cent basic rate as being realized in the year n when the final crop is cut, as G_n. In this year n it is expressed as:

$$(S_c + C + E)\,1.0p^n - E + G_n = Y + S_c$$

Then $$G_n = Y + S_c - (S_c + C + E)\,1.0p^n + E$$

E. g., the cost of land is $5.00 per acre, planting $15.00 and annual expenses $.30. The crop at 50 years is worth net $360.00 per acre and soil remains at $5.00 and will be sold as cutover land. Then, for the 50th year on a basis of 5 per cent,

$$G_n = \$360.00 + 5.00 - \left(5.00 + 15.00 + \frac{.30}{.05}\right) 1.05^{50} + \frac{.30}{.05}$$
$$= \$72.85$$

In any year a, the gain G_a is

$$(S_c + C + E)\,1.0p^a - E + G_a = \frac{Y + S_c}{1.0p^{n-a}} - \left(E - \frac{E}{1.0p^{n-a}}\right)$$

$$G_a = \frac{Y + S + E}{1.0p^{n-a}} - E - (S_c + C + E)\,1.0p^a + E$$

e. g. at 30 years

$$G_a = \frac{360.00 + 5.00 + 6.00}{1.05^{20}} - 6.00 - (5.00 + 15.00 + 6.00)\,1.05^{30} + 6.00$$

Cancelling E and solving,

$$G_a = 139.82 - 112.36 = \$27.46$$

or $$G_a = \frac{G_n}{1.0p^{n-a}} = \frac{72.85}{1.05^{20}} = \$27.46$$

In the year just after removing the crop and previous to planting, both the cost value and the capital value represent the value of bare soil and the gain G_0 is the difference in these values.

$$S_c + G_0 = \frac{Y + S + E}{1.0p^{n-a}} - E - C$$

$$G_0 = \frac{Y + S + E}{1.0p^{n-a}} - (C + E) - S_c$$

e. g. In the initial year, before planting,

$$G_0 = \frac{360.00 + 5.00 + 6.00}{1.05^{50}} - (15.00 + 6.00) - 5.00$$

$$= 32.35 - 21.00 - 5.00$$

$$= 11.35 - 5.00 = \$6.35$$

And $$G_0 = \frac{G_a}{1.0p^a} = \frac{27.46}{1.05^{30}} = \$6.35$$

For continuous forestry, the value of bare land just after cutting represents the value of all future crops or net income. These future profits are just as much a part of the entrepreneur's gain as is the net gain from the first crop. The difference is that the gain is appraised not on the basis of sale value of cutover land but of its *capital value* instead, or S_v. The above formulae apply with the substitution of S_v for S_c, or of

$$\frac{Y - C}{1.0p^n - 1} - (C + E) \text{ for } S_v$$

E. g. The capital value of land in the above example is, at 5 per cent

$$S_v = \frac{360.00 - 15.00}{1.05^{50} - 1} - (15.00 + 6.00)$$

$$= 32.95 - 21.00 = \$11.96$$

Then, at 50 years

$$G_n = 360.00 + 11.95 - (5.00 + 15.00 + 6.00)1.05^{50} + 6.00$$

$$= \$79.80$$

At 30 years, cancelling E, and omitting:

$$G_a = \frac{360.00 + 11.95 + 6.00}{1.05^{20}} - (5.00 + 15.00 + 6.00)1.05^{30}$$

$$= 142.44 - 112.36 = \$30.08$$

At 0 years, previous to planting;

$$G_0 = \frac{360.00 + 11.95 + 6.00}{1.05^{50}} = (15.00 + 6.00) - 5.00$$

$$= 32.96 - 21.00 - 5.00$$

$$= 11.96 - 5.00 = \$6.96$$

or $$G_0 = \frac{G_n}{1.0p^n} = \frac{79.80}{1.05^{50}} = \$6.96$$

This last value is equivalent to $S_v - S_c$ which, at this year, gives the appraised value of the entrepreneur's gain. It is evident that the entrepreneur's gain disappears when $p = x$. If land or timber can be bought for a price less than that shown by capitalizing its appraised value at the basic rate desired, or p, the purchaser can then reasonably expect to realize a gain above this interest return.

The principles illustrated by the above simplified formula and example apply in all cases, including any additional items of incidental cost or income and can be worked out for the other problems given in the text by finding both cost value and capital value for the year desired, at the rate selected for p. The difference is always the gain or loss for that year, directly convertible into that for any other year of the period.

CHAPTER XIII

PRINCIPLES UNDERLYING THE APPRAISAL OF DAMAGES

112. The Universal Principle of Damages. — The main principle underlying the awarding of damages is to put the plaintiff in the same position in so far as money can do it as he would have been had there been no injury sustained. On this basis the measure of damages is the difference in value of the property as a whole before and after the damage. The value of the part destroyed does not ordinarily equal this loss to the whole, and is determined only as a means or aid in appraising the true amount of the damage. E. g., destruction of a part of the timber on a logging unit lowers the stumpage value of the remaining undamaged timber. This loss must be added to the value of the trees destroyed to get the measure of the damage to the property as a whole. A planted grove on a prairie farm adds a greater value to the whole farmstead than would be represented by the value of the trees in the grove for lumber or fuel and the damage if the grove is destroyed will be this loss in total property value.

In some cases the damage is based on the value of the part destroyed. This principle should not supercede the former, except when it is an adequate measure of compensation. Whether it is employed or not depends largely upon the form of the claim made by the plaintiff. If this claim is based on the value of the part destroyed, it will be assumed as a sufficient compensation.

"If the wrong consists in the destruction or removal of some addition, fixture, or part of the premises, the loss may be estimated upon the diminution of the value of the premises, if any results; or upon the value of the part severed, considered either as a part of the premises or detached; and that valuation should be adopted which will be most beneficial to the injured party, for he was entitled to the benefit of the premises intact, and to the value of any part separated." Sutherland on Damages, Vol. 3, p. 373.

"The damage done to trees standing and growing on the land is the difference in the values of the land before and after the tortuous act." 28 Am. and Eng. Enc. Law (2d ed.) 544.

113. **Method of Settlement of Damages.** — Damages are payable in money, not in kind. Compensation, not physical restoration, is required. In evaluating the loss, the method may be a private settlement between the parties. This is materially aided by previously drawn contract agreements. Wherever users or permittees are apt to cause damage incident to their use of property, as in sale and logging of timber, grazing or leasing, the owner and user can agree in advance as to the penalties or damages which must be paid if damage is caused through this use. Such arrangements may cover the cutting and removal of classes of timber prohibited in the contract, and the occurrence of fire through fault of the permittee.

In the absence of private settlement, damages are awarded through civil action, initiated by a suit. Where property is condemned and taken for public purposes special appraisers may be appointed by the court. In any civil case, the judge or jury consider all evidence, reject such as does not seem to conform with sound principles of valuation, and arbitrarily fix the amount of the damages, basing their judgment on the facts in the case. An analysis of the basis of the award is seldom given.

114. **Possession and Use the Basis of Damages.** — It is assumed that the plaintiff is entitled to continue in possession of his property and intends to make the most profitable use of it which its character permits. This use is indicated by the successful practice of the owner, and by experience of others in the vicinity.

Market value for the property cannot be accepted as final in determining its true value either before or after the damage. "Market value is merely prima facie evidence of the probable true value. The market value is not conclusive on this point, and if necessary to arrive at an equitable estimate, any other pertinent facts and circumstances which may tend to throw light on its actual value may be considered." Brief filed by U. S. Attorneys in Chicago, Milwaukee, and St. Paul Railway Co. of Idaho vs. United States of America. 244 U. S. 351.

Where property is but partially developed, market value may represent forced sales or wrecking value to the owner, who is entitled instead to compensation for loss of the discounted value which he is creating and will normally realize in due time.

115. **Equitable Standards of Valuing Damages.** — Damages

must be appraised on a basis of common or social values. The purposes of awarding damages is to compensate the individual, to protect rights in property and to encourage legitimate enterprise. Civil damages cannot be collected from persons who themselves have no property. In such cases, violation of a public statute may justify criminal action, but the damaged party remains uncompensated. Damage is always an absolute loss to the community, and to the owner. Only in case the defendant possesses property which may be taken through a judgment can this loss be transferred to him.

It is just as necessary to protect the defendant and his property from extortionate claims for damages as it is to protect the plaintiff. "The rule of law is that the person who claims the damages must use every reasonable effort to diminish, lessen and keep low the damage."* A plaintiff is not justified in asking damages for injury which, although resulting from the act of the defendant, the former could have checked and minimized.

A second reason for adopting generally recognized standards is that values which are peculiar to a single individual cannot be determined with even approximate accuracy. By its very nature, value is created by and measured in terms of the tension between buyer and seller, reduced to prices in money (§ 31). When an individual refuses to be bound by these social forces, yet attempts to quote a money value for an individual opinion or sentiment, it does not constitute a reason why a public agency should be similarly bound.

This does not mean that sale value must perforce be accepted, for this may do the individual an injustice and work an economic injury. Rather, the value recognized must be such that it would apply equally well to any other person who might own and operate the property for a similar purpose.

The problem in appraisals of damage is first to find a fair value for the property previous to the injury, second, to determine just how much loss in total value has occurred. Since no actual sale is contemplated except in condemnation suits, the evidence may be taken from three sources, namely, appraisal of use value or capital value to owner; of cost value; or of market value; followed by an appraisal of the loss suffered as affecting whichever

* Marion Low vs. N. Y. Central & Hudson River R. R. Co. Charge to jury.

of these values is accepted. The final decision as to value and amount of damage suffered will depend on the weight given to the evidence from any or all of the above sources, as expressed in the opinions of witnesses.

116. Appraisals Based on Capital Value. — Especially with land and timber, the most logical basis of value is use or future net income expressed as capital value (§ 41). The objections or drawbacks to this method are that it may constitute merely a personal or relative value (§ 25) and that it depends upon future elements which cannot be determined exactly. The greatest difficulty lies in deciding on a basic rate of discount to use in capitalizing the prospective income (§§ 80 and 90). Yet whenever loss of income can be definitely determined, this element is given more weight than any other in appraisals of damage.

The fact that this difficulty exists will not bar such estimate as uncertain provided the method can be applied with a reasonable amount of accuracy. It is sufficient if there be such certainty as will satisfy the mind of a prudent and impartial person.

"The law never insists upon a higher degree of certainty than the nature of the case admits, but certainty, so far as the nature of the case admits of, is to be aimed at and attained. No greater degree of certainty in the evidence upon which damages are to be estimated is required than in respect to any other branch of the case or any other class of civil actions. Absolute certainty is never required. As there can be no recovery for damages for remote possibilities, neither will the existence of remote possibilities defeat a recovery, which is but another way of saying that absolute certainty is not required."* Uncertainty surrounding the determination of capital values for timber is reduced first by the adoption of present market prices of mature timber as the future stumpage value of timber now immature (§ 121), second, by basing future costs on present known costs (§ 117), and third and perhaps most important, by substituting the rate earned x for an arbitrary choice of a rate p for discounting future income (§ 111).

This reduces the uncertainties of the method to the single factor of predicting the probable quantity and quality of future yields of timber from the property. This is no more difficult than to predict the yield of a field of wheat, or of an orchard. Such

*8 Am. and Eng. Enc. Law (2d ed.) p. 610.

yields occur in the natural course of events and their measurement comes within the definition of reasonable certainty. The standard should be the average yields which similar stands of timber have produced on similar sites in equal periods of time, from which the probable yield of the stand in question may be judged. Standard yield tables are the basis for determining such yields, when reduced by adequate discounts for average or subnormal stocking.

117. **Appraisals Based on Cost Value.** — Actual past costs are frequently accepted as the basis of damages because these can be ascertained with considerable certainty, which factor outweighs others in the minds of the jury. This certainty depends first on records, and second on the elimination of all consideration of market values or use values.

If records are relied on, these fall into the divisions of general cost of administration and protection, and specific costs of production (§ 89). For both items, the cost must be allotted to the area damaged. Actual past costs by years are seldom used in such cases, though giving the highest degree of certainty. Instead, current average costs for the same operations and conditions should be used.

Past costs are based on past economic conditions. These conditions have changed and it is not possible in the future to repeat the results obtained. The work will cost either more or less than before. In neither case is past cost the true measure of damages. Again, past costs are those incurred by an individual who may have been more efficient than the average, or less so. If his costs have exceeded the average cost he is rewarded for inefficiency (§ 115). If he has been economical, his ability is penalized. For these reasons, average and not actual costs should be used, and the merit of adhering to a record of facts is seen to be fictitious. The main objection to this method is that cash costs alone do not measure the loss in actual value (§ 29). That the value of property, especially of growing timber, must necessarily increase rapidly and exceed the sum of the cash costs is obvious. When timber is mature and salable, its value has nothing to do with the cost of producing it. Virgin timber that has cost practically nothing in labor sells for as much as the products of planted groves if the two are of equal quality and accessibility (§ 139). The effort to approximate this increase in value by

adding interest to cost (§ 23) based on any rate p arbitrarily chosen, introduces the same element of uncertainty as for capital value. Value is not dependent solely on cost nor is any given rate guaranteed as a return on such costs (§ 27). For the above reasons, the advantage of certainty in the use of costs as a basis is more apparent than real.

By substituting average current costs and allotting them on a per acre basis, and by determining the rate earned x in place of any arbitrary rate p, cost value is made to conform to the same standards of probability as capital value, and by this method the appraisals of cost value and of capital value are identical (§ 111).

118. Appraisals Based on Market Value. — Market value indicates most closely the true value of property and should be accepted whenever possible as the basis for appraisal of damages, yet (§ 114) such values are not final. Market values are the ultimate rather than the direct basis for appraisals of loss to property values. If cost value is used, the original cost of the property is the market value which it had at time of purchase. The cost of subsequent operations depends on the market value of labor and materials. In capital values, the basis of valuing income is the market value of the products. There is no escaping this ultimate basis, which is the expression of the two forces without whose operation value would not exist and could not be measured (§ 31).

If it were possible always to measure the true loss to the owner directly as loss of market value of the property, no other method of appraisal need ever be used; but such is not the case. The property itself is not sold, but only appraised. No sales of similar land or property may have been made which are comparable in point of time or locality, hence acceptable as a basis of appraisal. The owner does not want to sell, and the property may not be in condition to sell to advantage. Growing crops are involved whose market value is not matured. The value of half-grown wheat or apples based on the condition or utility of the crop is practically nothing, but based upon the matured product can be easily determined. The value of a pure bred calf for veal is not a proper measure of its true worth. The greatest danger thus consists in substituting the market value of the part destroyed for loss to value of the property as a whole, when the part destroyed represents an immature crop. In these cases, true

market value should be based on the value of the crop at maturity, and the difference in value of the land if the crop is destroyed during its growth should be determined irrespective of the actual market value or lack of value which the part may have when destroyed. This rule applies to land bearing young trees (§ 112).

"The true rule is not the actual value of the trees for firewood but the damage done to the land by reason of destroying them. This damage should be estimated by all the circumstances, and the purpose for which the trees were used or designed." Chipman vs. Hibbard, 6 Cal. 163.

"If trees have no value when separated from the land the only cause of action which arises from their destruction is one for damages for injury to the land, the measure of damage in such case being the difference in value of the land before and after the injury." Galveston H. & S. A. Ry. Co. vs. Warnecke, 95 SW 600 (Tex. cw. app. 1906).

"Growing trees are a part of the realty to which they are attached and the destruction of trees is an injury to the realty for which action will lie. If the suit is for damage to the realty, the plaintiff could not be restricted in this recovery to the value of the trees when detached from the soil." Ibid.

Market values definitely fail in the appraisal of damage to forest property containing young timber whenever public opinion has failed to properly base the value of this young timber on values of the final crop or mature trees. Yet the true market value of these mature stands is always recognized and can be closely appraised, and the market value of land, irrespective of or ignoring the stand of young timber, can usually be ascertained. This condition is widespread in America because of the abnormal and transient factors which, through prevalence of fire and excessive taxes on cutover lands, cause private investors to regard young timber as of no value and to expect it to be burned up or the land confiscated by tax burdens, and to fail to recognize real opportunities for investment which come with better fire protection and remedial tax legislation.

This gives the entrepreneur in forestry a tremendous opportunity for profit, attended by a commensurately large risk, not the least element of which is the possible refusal of courts to recognize these crop values because they have not yet become established as market values through recognition in sales of such property.

When such conditions exist every effort should be made, in the interest of public welfare, to establish the true value of immature timber as the basis of damages under the generally accepted principles outlined in § 112 and § 114.

119. The Physical Basis of Appraisals. — An appraisal of damages is an attempt to estimate a loss due to physical damage to property. The first step is to determine the extent and character of this damage as a preliminary to its valuation.

The physical elements of an appraisal of forest property consist of soil, mature timber, immature timber, forage, and possibly fish and game. The indirect elements are watershed damage, which is to both land and forest cover, and damage to scenic and recreational values.

All of these elements of damage must have a physical basis. On this basis also depends the indirect loss of value to undamaged portions and to the entire property.

When timberlands are damaged by fire, a map must be made to determine the area burned, and a survey or estimate of the standing timber to ascertain the quantity, kinds, sizes or ages of the trees killed, the distribution and percentage of the stand which they represent, and the extent of damage done to surviving trees.*

If the timber is completely killed this survey can be made at once. When the tops have been scorched and partially killed, it is frequently necessary to postpone the examination until after the next growing season, by which time the death or survival of doubtful trees will be more clearly evidenced.

120. Appraisal of Soil Value. — In appraising values of bare soil or separate values for soil and timber, the original actual cost of such land is seldom if ever acceptable. In many cases this particular tract was probably timbered when purchased. There may never have been a sale as when public lands have been retained by the nation or state. In other instances the last sale is remote in time and does not indicate the present value of such land.

Attempts to appraise land on the basis of capital value or discounted income is open to the objections cited in § 29 and § 116 but magnified especially in the case of forest land by the abnormally long periods of discount. So great is the difficulty pesented by the one item of the interest rate p, that modern writers

* Chapman's Forest Mensuration, Chapters XX-XXI.

on land economics tend to reject this basis of land valuation altogether, in favor of appraisals based on such evidence as is available indicating market value.*

This forces the examiner to depend on sales of similar land, or approximate market values, hence data on such sales is of primary importance. Contemporaneous sales are given most weight. Past sales come next in importance, and capital value is unreliable and unsatisfactory until crystallized by sales (§ 31). The objective is to appraise the present market value of the land. This value, and neither the past cost of the land nor its capital value (§ 29), must always be taken as the basis of appraising damages to landed property. The effect of a change in market value of land since the original purchase is to increase or decrease the probable rate x earned by the investment. It is in effect a recapitalizing of future income up or down in the light of experience (§ 44).

A change in land value affects the separate value of the young standing timber independent of final value of the crop. Fig. XII.

E. g. Land was purchased originally at $5.00 per acre, but at the time of the appraisal the market value of similar bare land is $20.00 per acre. The crop, at 50 years is worth $52.33 which earns 5 per cent on the cost but only 2.6 per cent on the market value of soil. This crop is totally destroyed and is valued in each of the above cases by applying this rate earned or x per cent (§ 110).

At any intervening year, the net value of the young timber, whether obtained by cost value or by capital value, will be considerably less if based on $5.00 land and 5 per cent than it will on the $20.00 market value of the land and 2.6 per cent. This is due to the difference in the discount curve caused by the lower rate earned on the larger initial investment in land. At 25 years, the crop on $5.00 land is worth $11.93, while on $20.00 land the same crop is worth $19.00 at this age, or a difference of $7.07. In this example all operating costs are omitted for simplicity. They would not affect the principle set forth.

The owner is entitled to receive any benefit which may accrue

* "Soil value must be derived from the free operation of supply and demand, since it alone is clear and as free as possible from the caprice and instability of human perception." Incendies en Forét, A. Jacquot, translation by C. E. C. Fischer, Calcutta, Supt. Govt. Printing, India 1910, p. 55.

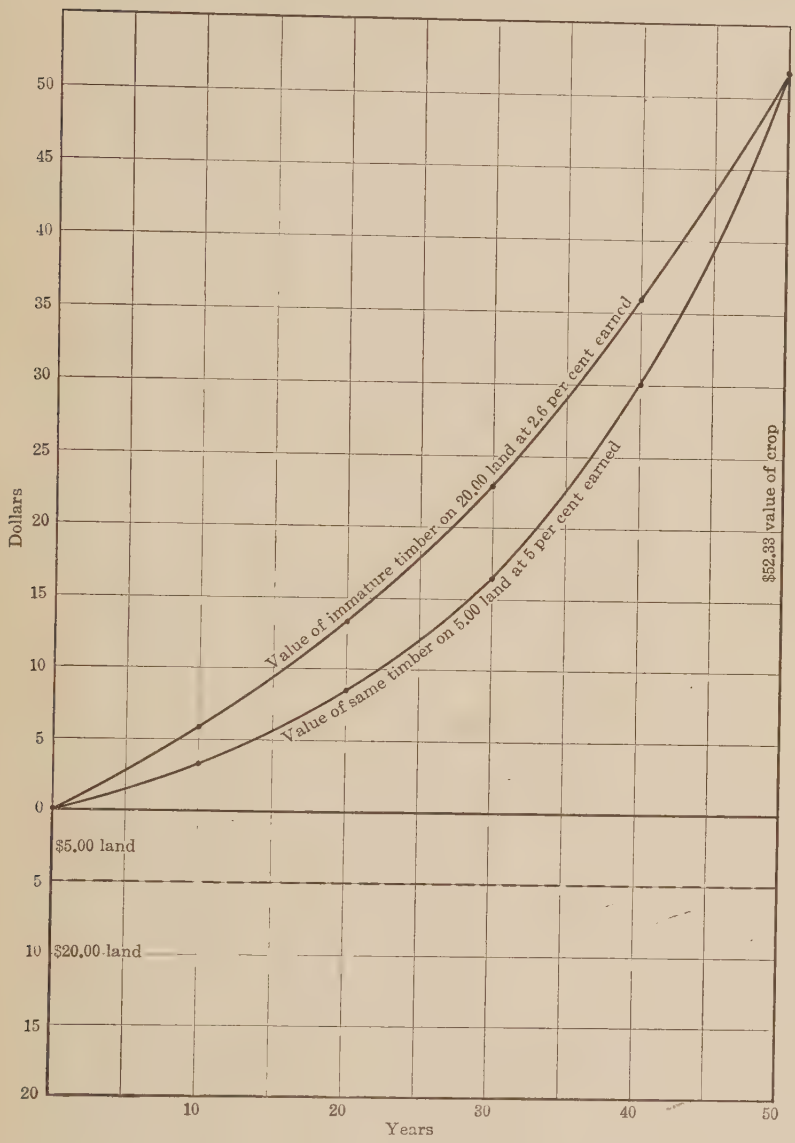


FIG. XII.—Effect of increase in value of land on appraised value of young timber when rate earned x is used and operating costs and income are unchanged.

from changes in the market value of the soil since the property was acquired, whether caused by increased prices of the product or by a fall in the basic rate of interest, and he must bear any loss from a shrinkage of these values.

A soil value must always be established as a prerequisite in appraising damage to forest property growing even-aged stands of timber (§ 133). Only in case land is considered to have no value on the market should it be neglected in such an appraisal.

121. Appraisal of Merchantable Timber. — The value of merchantable timber is required in three different cases, first for timber now mature and salable and which can be logged in the immediate future; second for mature timber which is at present inaccessible but can be logged at some future date dependent on the development of transportation facilities or of markets; third for timber not yet mature which must be valued on the basis of its future merchantable volume.

The appraisal of mature salable timber is treated in chapters XV-XVII. As in the case of land, market values if established by recent sales of similar timber similarly located as to markets and costs of logging are the most reliable basis of value. In the absence of such sales, appraisals must be made which will be based on sale value of the manufactured products or lumber and never upon the cost of growing the timber (§ 124).

Timber which cannot be logged now has a lower market value than that sold for immediate cutting, but even timber which is now inaccessible if in large bodies and of good quality will have a market value, although an appraisal based on logging costs would not show it. Such values represent discounted future prospects and must be accepted as true market value (§ 125).

The purpose of appraising the future market value of timber now immature is to arrive at a fair present value for this young timber. Since all prices change, the market value of stumpage at any future date will be different from what similar timber is worth to-day. Attempts are sometimes made to predict future values of stumpage by means of curves based on past increases, and the rate of increase expressed as a per cent of present values, e. g. as an increase of 1 per cent annually.

The adoption of different values for future stumpage is legitimate when its use is merely a speculative calculation or personal appraisal of capital value and prospective gain (§ 25),

but it is entirely wrong in principle when applied in the determination of damages or public values (§ 116). Such predictions are mere guesses. The trend of prices may be upward, but no one can predict the rate of this change and hence the correct future value. The introduction of these speculative stumpage values at once invalidates an appraisal of damages. It is not the function of such an appraisal to attempt to interpret future market prices. On the other hand, prices established by the present markets are based on fact, and these prices must be assumed to apply to the value in the present not merely of timber now merchantable but of young timber when it becomes mature. When present stumpage prices are adopted as the basis of damages for destruction of young timber, this speculative element is eliminated and the appraisal in this feature is put upon the same basis of certainty as by the adoption of present land values and present scale of costs (§ 116).

"It is obvious that in estimating the damage sustained under this method (capital value) the market value of the timber at maturity must be assumed to be the present market value of the mature timber of the same species." Brief of U. S. Attorneys, Chicago, Milwaukee and St. Paul R. R. of Idaho vs. United States of America, 244 U. S. 351.

122. **Appraisal of Immature Timber.** — It has been shown that for land bearing immature timber, market values of the land before and after the injury may or may not give an adequate basis for damages (§§ 114 and 118). On the other hand, personal or relative appraisals based on either cost or capital value at an arbitrary rate of p per cent are equally objectionable (§ 110) and should never be used.

In the absence of an adequate basis in market value for the property as it stands, the appraisal must rest on the double foundation of market values for the land on the one hand and for merchantable timber on the other, both based on present prices instead of past or future values.

The rate earned x or the mean annual forest per cent (§ 107) is the connecting link which unites these values and indicates the appraised value for young timber of any age. When the rate is determined, the cost value and capital value are identical for any year, while if any other rate is used, these two values always differ (§ 110). An appraisal on this basis compensates the owner

fairly at the exact rate which he was earning, thus putting him in the same financial position now as he would be if he retained the property. Fig. XI, page 153.

"In speaking of the value of the growing crop at the time of the injury, what is meant is the value for the purpose of continuing its cultivation to maturity, for in most if not all cases it would be valueless for any other purpose. In ascertaining the value of growing crops, proof must be had either as to the market price or its intrinsic worth, and it follows that any witness who undertakes to speak intelligently as to its value must base his figures on a sound estimate of what the crops would produce if well-cultivated and uninjured and to deduct from that result the cost of cultivation and marketing." Raywood Rice Canal and Mill Co. vs. Langford (Tex. Civ. App.), 74 SW 926.

"When elements of certainty are lacking by which damages can be accurately measured, resort must be had to such principle or basis of calculation applicable to the circumstances of the case as will be most likely to approximate certainty and which may serve as a guide in making the most probable estimate of which the nature of the case will admit."

"A principle or basis of calculation may be resorted to if, though it may be less certain as a scale of measurement, the principle is just in itself and more likely to approximate the damage than some rule which, though certain, must produce injustice by excluding a large portion of the damage actually sustained." Gilbert vs. Kennedy, 22 Mich. 117.

The principle or method above set forth of basing the value of the growing crop of timber upon present market values of land and of mature timber, and upon the mean annual forest per cent or rate x earned, has for many years received the approval of French foresters and recently of the U. S. Forest Service. It is urged as the only adequate basis for such appraisals, fair alike to plaintiff and defendant.

The preparation of general yield tables for different species of timber and forest sites will greatly facilitate accurate appraisals of land bearing immature timber crops.*

123. **Appraisal of the Damages or Loss in Value.** — With a correct appraisal of the property in its condition previous

* Chapman's Forest Mensuration, Chapters XXVIII-XXIX.

to the damage as a basis, the loss in value may be determined by one of the following methods.

1. Direct reappraisal of market value of the entire property.
2. Appraisal of the value of the parts destroyed, plus additional loss in value of the property as a whole.
3. Appraisal of loss in value of parts damaged but not destroyed plus additional loss suffered in consequence to the whole.

The first method is most serviceable when the damage done to the whole property considerably outweighs the value of the parts destroyed, as in the case of park or recreational features.

The second and third methods are of practically universal application in appraising damage to commercial forest property. The loss in value in addition to that of the timber destroyed has a double application, first, to the land actually burned over, and second, to the remaining unburned area. The damage caused by a fire which destroys standing timber is usually in excess of the net value of the timber killed when the trees are unmerchantable, even when this young timber is appraised at its full capital value. The soil or site is usually less valuable after a fire than it would be following normal cutting, and such additional losses must be included.

Damage to commercial forests can always be determined by the following rule: to the appraised value of the part destroyed, or loss in its value if only damaged, add *increased cost* in reëstablishment of a new crop, or the *loss in the capital value* of this new crop or both, plus loss in value to the undamaged portion of the property resulting from this damage. Value depends on net income. Future costs, whenever they intervene between future income and the present, reduce its capital or present value by the exact amount of the discounted cost (§ 95). This is the basis for the above rule. The appraised soil value is assumed to rest on normal future costs. If, as the result of fire which wipes out a stand, an extra or abnormal cost of $10.00 per acre is made necessary, this normal value suffers to just that extent. If the land minus the timber was worth $20.00 per acre, this enforced extra cost lowers this value to $10.00 per acre.

This principle is sometimes applied even when the land is worth less than the extra cost, as in case of $5.00 land, which would in theory be worth minus $5.00 after the fire. A minus appraisal on

land indicates that a smaller rate x will be earned unless the value formerly possessed is restored. The owner is entitled to the equivalent of his loss in value, or to the rate x, regardless of the appearance of negative values of land. This principle is adopted by the U. S. Forest Service on the National Forests, where, although land is not given any value, a cost of $5.00 for planting is included whenever natural reproduction has been rendered impossible by the destruction of seed trees.

In the same way, a loss in the value of a future yield, which loss cannot be covered by an increased expenditure such as for planting, but which indicates an actual loss in productiveness of the site, must be capitalized (§ 95) and indicates the damage from this source. The sum of these damages plus the damage to standing timber gives the true loss to the portion burned over to which is then added any effect on value of the remainder. or whole.

CHAPTER XIV

THE APPRAISAL OF DAMAGES TO FOREST PROPERTY

124. Damage to Merchantable Timber. — The methods set forth in this chapter are for the guidance of persons who may be called upon to testify as to the value of property before and after damage, in arriving at an appraisal based upon facts and conforming to sound principles.

The facts which a jury must consider include those tending to establish the responsibility of the defendant for the damage, showing the extent and character of the physical damage, and indicating the value of this damage. It is the last of these three considerations which is dealt with here.

Timber killed by fire or from other causes is saleable if accessibly located and in quantities which permit of its being logged before it becomes worthless from decay and insect depredations. When great quantities of timber are destroyed, as in the fires of 1910 in Idaho or the blowdown in the Olympics in 1923 in Washington, only a small portion can be salvaged due to limited markets and prohibitive costs of logging. The logging of drought-killed longleaf pine in the South in 1925 required the concentration of the cut for many months on this timber and a considerably increased cost of logging due to the scattering of the operations over a wide area. Losses in fire-killed timber are caused by actual consumption of a part of the timber by severe fires, loss of quality and grade, through partial burning, increased costs of logging, disruption of logging operations which is a damage to the whole property by increasing normal costs, subsequent deterioration of the standing timber in either dead or living trees and disruption of the management of the forest for sustained yield. Since few forests have been brought under such management this last element of damage can seldom be appraised, but it is a factor always present in regulated forests and frequently in logging.

An estimate of the standing timber before and after the fire is first required (§ 119). If former estimates are lacking or are unreliable, the stand as it existed previous to the fire is usually determined in the estimate of damage. Based on this estimate the

possibility and cost of salvage is next appraised. If the appraisal can be put off until the completion of actual salvage operations, so much the better, since the quantities logged or abandoned and the increased costs of logging can be taken from the records. Otherwise these factors are estimated. In this appraisal is included the resultant cost of logging the remaining timber not damaged by the fire. If it is impossible or undesirable to log this unburned with the damaged timber because the latter requires the entire resources available or absorbs the entire market, the appraisal of this residual timber must be based on the cost of a separate operation.

The sum of net stumpage values for the damaged and the undamaged timber for the given logging unit is then subtracted from the original stumpage value and the difference represents the loss in value of the property from damage to merchantable timber.

$Y =$ Value of merchantable timber on entire tract previous to damage.

$Y' =$ Value of same subsequent to damage, including value of salvage.

$D =$ Damage to merchantable timber.

Then $D = Y - Y'$

Interest may be included in such damage when settlement is delayed.

E. g. In the case of Low vs. New York Central and Hudson River R. R. Court of Appeals, State of New York, 1914, plaintiff introduced testimony to show that the whole property burned was originally worth $400,000, and that after the fire it was worth $180,000 or a damage of $220,000. The defendant admitted a loss in value of $27,870.50. The damages were based on the stand of hardwoods and softwoods, the loss in value per cord of softwoods killed, the per cent of hardwoods killed and subsequently dying from the effects of the fire, the rate of deterioration of these hardwoods and the possibility of salvage, on all of which questions of fact wide differences in testimony appeared. The verdict was for $90,000 and costs. Interest was included but the amount was not stated.

125. Damage to Timber which Cannot be Logged Immediately. — When for any reason timber *cannot normally* be logged for a period of years, salvage value will be materially reduced or

if the timber is killed, may entirely disappear. The stumpage value of this timber is its present market value as determined by the known condition that it cannot be logged until a future date. Its merchantable condition at that time is therefore the basis of appraising the damage to this present stumpage value. The reduced volume of merchantable stumpage which can be logged in the future is calculated as a probable per cent of the present stand, allowing for deterioration, and any loss in value per thousand board feet to this residuum due to increased cost of logging or loss in quality is appraised, to determine the per cent of the

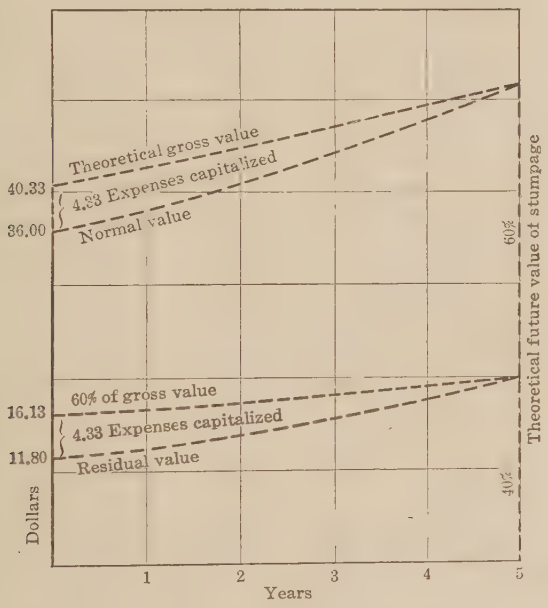


FIG. XIII.—Derivation of net stumpage value of damaged timber when logging is postponed.

stumpage value of this present stand which can ultimately be obtained.

Such losses may be heavy due to progressive dying of trees injured in the fire and to entrance of rot and of insects in fire scarred butts. There is certain to be increased logging cost if any great proportion of the stand is killed. When the timber deteriorates to a point where the residual value of the products will no

longer pay for the cost of logging, the stumpage value *at time of logging* is zero, or a total loss.

At the time of the fire this value may shrink to zero before it entirely disappears at the future date of logging, for the stumpage value at any future date must equal the cost of carrying the investment to that year.

E. g. The annual expenses on a tract of hardwoods are, with taxes, 85 cents and the land "rent" is 15 cents per year, or a cost of $1.00 per acre annually. The timber cannot be logged for 5 years, and taxes are not to be reduced. The present discounted value or cost of this expense at 5 per cent is

$$\frac{1.00}{.05}\,\frac{(1.05^5-1)}{1.05^5} = 20.00\left(\frac{.2763}{1.2763}\right)$$
$$= \$4.33 \text{ per acre}$$

This sum must be deducted from any appraised salvage value. If this future value is but $4.33 per acre, the timber is now a total loss, since present net stumpage value is zero.

The present stumpage value of timber not harvested until a future date, whether this timber is now ripe or immature, is in no case equal to the future value discounted, $\frac{Y}{1.0x^{n-a}}$ but is always less than this value by the amount of the future expenses as indicated above. This presumption applies to standing mature timber, hence, present

$$Y_a = \frac{Y_n}{1.0x^{n-a}} - \frac{e}{.0x}\left(\frac{1.0x^{n-a}-1}{1.0x^{n-a}}\right)$$

as illustrated.

This deduction must be made from *any* future stumpage value, hence is made from *both* the value of the undamaged timber and from the damaged timber. These deductions being the same, the *loss* in value of the stumpage is not affected by them, since this is a margin. E. g. If future stumpage is worth $50.28 per acre, and a loss is suffered of 60 per cent at time of logging, the present value of the undamaged timber is:

$$\frac{50.28}{1.05^5} - 4.33 = 40.33 - 4.33 = \$36.00.$$

For the damaged timber it is

$$\frac{.40(50.28)}{1.05^5} - 4.33 = \frac{20.58}{1.05^5} - 4.33$$
$$= 16.12 - 4.33$$
$$= \$11.79$$

The damage is

$$36.00 - 11.79 = \$24.21$$

Since expenses cancel, the damage (not the value of the crop) can be found directly by the formula:

$$D = \frac{Y_n - Y'_n}{1.0x^{n-a}}$$

e. g.

$$D = \frac{50.28 - 20.58}{1.05^5}$$
$$= 40.33 - 16.12$$
$$= \$24.21$$

In following precedent, it is preferable to show the present value before and after the fire directly, as by the first illustration, and the damage as the difference in these values.

In the above case, a future stumpage value per acre has been assumed instead of the actual present market value of the timber. It is this present value which must be made the basis of the appraisal of a given per cent loss in future stumpage value. E. g. It would be incorrect to take 60 per cent of the present value as the loss, unless the future expenses will also be reduced by the same per cent consequent on the damage, as in reduction of taxes. If these remain the same, the loss is equivalent to 60 per cent of the *gross,* not the net, present value. *The gross value is the net value plus the discounted expenses.*

e. g.

Net value	$36.00
Expenses	4.33
Gross value	$40.33

Loss, 60 per cent of gross value = $24.21

or

$$D = .60\left(Y_a + \frac{e}{.0x}\,\frac{(1.0x^{n-a} - 1)}{1.0x^{n-a}}\right)$$

To express this loss as a difference in present value of stumpage, the net value after the fire is found by taking 40 per cent of the

gross present value instead of the net, and deducting the expenses from this value, thus giving $11.29. If instead, 40 per cent of net present stumpage value is taken as equaling the damages, this gives $21.60 which falls short by $2.60 of the true damages. See Fig. XIII, page 177.

The above example would apply to a stand of 8,000 board feet of hardwoods with a present stumpage value of $4.50 in which the total future loss from all causes due to the fire is 60 per cent at the time of logging.

126. Total Destruction of Immature Timber. — If the assumption is made for land bearing young timber that the value of the part destroyed even when correctly appraised gives the loss in value for the burned area, such appraisal will usually fall short of a true measure of damages (§ 112).

Under this assumption, when young timber is entirely destroyed by fire, the damage could be determined by subtracting the value of bare soil from that of the property or land bearing timber; hence (§ 110),

$$D = \left(\frac{Y + S + \frac{e}{.0x}}{1.0x^{n-a}} - \frac{e}{.0x} \right) - S$$

or in case thinnings were considered;

$$D = \left(\frac{Y + Th(1.0x^{n-t}) + S + \frac{e}{.0x}}{1.0x^{n-a}} - \frac{e}{.0x} \right) - S$$

e. g. The stand of white pine described in § 109 is completely destroyed by fire when 25 years old.

The rate earned $x = 5\frac{1}{2}$ per cent

$Y = 360.00$

Th_2 at 40 years $= 50.00$

Th_1 at 30 years $= 25.00$

$S = 10.00$

$e = .30$

$\frac{e}{.0x} = 5.45$

The appraised value at 25 years is:

$$V_{25} = \frac{\left\{ \begin{array}{l} 360.00 + 50.00(1.055^{50-40}) + \\ \quad 25.00(1.055^{50-30}) + 10.00 + 5.45 \end{array} \right.}{1.055^{(50-25)}} - 5.45$$

$$= \frac{\left\{ \begin{array}{l} 360.00 + 50.00(1.7081) + \\ \quad 25.00(2.9178) + 10.00 + 5.45 \end{array} \right.}{3.8134} - 5.45$$

$$= \frac{360.00 + 85.40 + 72.94 + 10.00 + 5.45}{3.8134} - 5.45$$

$$= \$134.52$$

from which the value of land, $10.00, is deducted, giving a net value for the timber at 25 years of $124.52.

The cost value of the same timber is:

Land	$S = 10.00$
Cost of establishment	$C = 15.00$
Weeding at 5 years	$C_d = 8.00$
Rate earned	$x = 5\frac{1}{2}$ per cent as before
	$e = .30$, and
	$\frac{e}{.0x} = 5.45$

Then (§ 110)

$$C_{25} = (10.00 + 15.00 + 5.45)1.055^{25} + 8.00(1.055^{20}) - 5.45$$

$$C_{25} = 30.45(3.8134) + 8.00(2.9178) - 5.45$$

$$= \$134.01$$

Subtracting the cost of land, the net cost value of the timber is $124.01, and the difference of $.51 between cost value and capital value in this illustration is due to the fact that the true rate earned is slightly greater than 5.5 per cent. The mean of these two values, $124.26, is mathematically correct.

127. **Separation of Timber and Soil.** — That the value of the part destroyed does not measure the loss in value of the whole is well illustrated by the destruction of young stands of timber. By the deduction or separation of the soil value S, above, it is assumed that the damage to the property is confined to the timber and that the soil is uninjured. This is practically never true. To understand the character of the additional damage done and the simplicity of the methods for appraising the damage, one should

grasp the distinction between physical damage and loss in value. While the latter results from the former, it is measured by economic factors which must be separately considered and which determine the appraisal. Soil may be completely destroyed, but unless this soil has value no damage is done. The amount of the damage is measured by the value of the soil. Hence the source of damages is loss, not of the soil fertility itself, but of the possible money income, and the measurement of the loss of income earned by the soil (soil rent or soil value) (§ 68) is the measure of damage. One of the greatest obstacles to fire prevention in the Lake States and elsewhere is that the public is still indifferent to the damage, believing that no values are being destroyed.

Whatever may be the fertility or intrinsic qualities of soil, its appraised value and in theory its market value is derived from the discounted future net income receivable from the crops which it will grow (§ 95). Appraisal of soil damage rests directly on this fact. This *value* of soil thus pre-supposes that the first rental or crop income will not occur before n years or a crop period. If the wait were longer than this, the soil would be worth that much less; if shorter, correspondingly more than S.

When the value S is separated from the total value of the property as in § 126, this is a true soil value only if the above condition of actual physical separation of soil and timber holds good, and the new revenue-producing crop can be established at once and will yield the same net income as the normal crop which determined the S value. To bring about such a condition in the middle of a crop period is not so easily done. It means that the growing crop is violently removed years sooner than its natural harvest period, that the soil is freed from this crop as effectually as would naturally occur in logging, that there is no greater cost attached to establishing the new crop under these abnormal conditions than would be the case if this occurred in the normal rotation, and further, that this new crop is just as valuable as if produced at the regular period. Instead of these conditions holding good, violent disturbances usually occur which either add greatly to the expense of reëstablishment or diminish the value of the new crop or both. The dependence of soil *value* on both the amount and time of payment of net income is shown in Fig. XIV.

The total value of the property for any year is the capital value of a net income which in Fig. XIV is $50.00, less capitalized

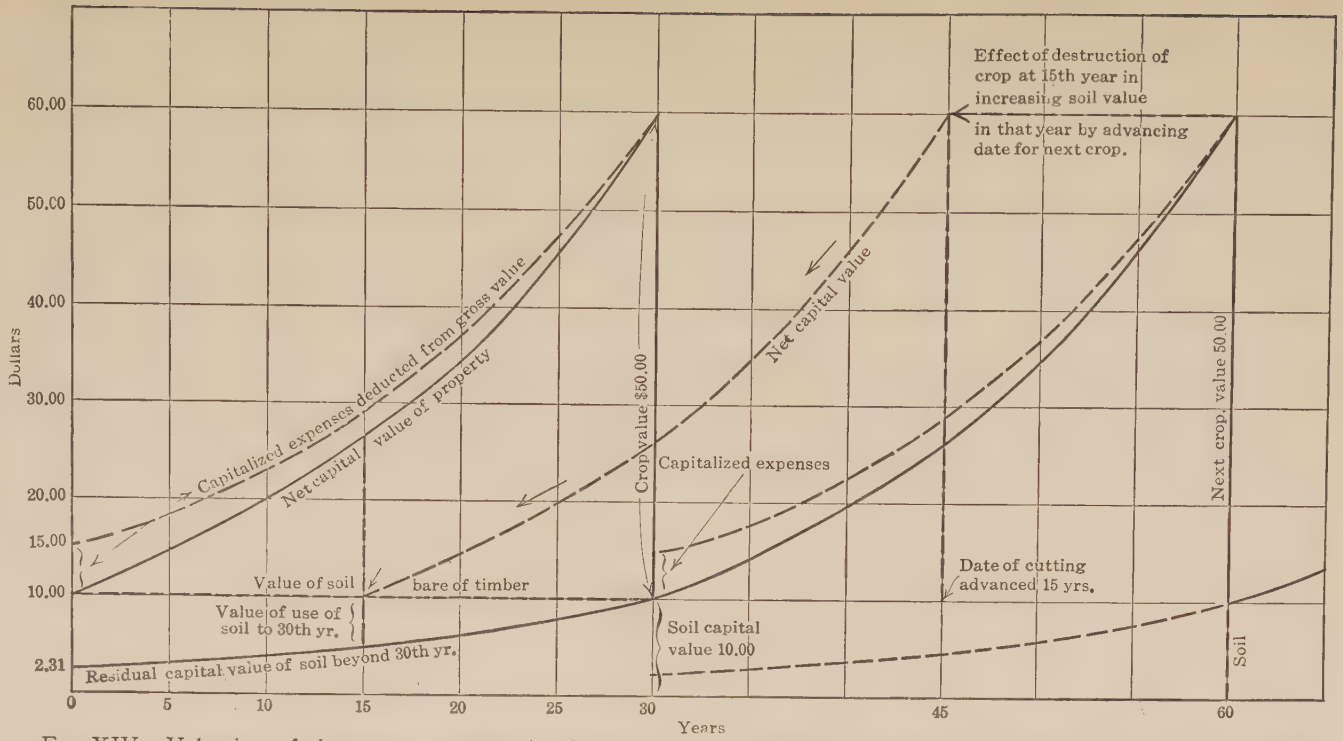


FIG. XIV.—Valuation of damage to property by destruction of a stand of young timber, showing relation of values of timber and soil.

expenses of $\frac{.25}{.05}$ or \$5.00. This value for year n or when soil is bare is \$10.00. Soil value is equivalent to that of future non-existent crops. With a crop on the ground, this value must be found by *discounting the value of bare soil,* or \$10.00. At 15 years, in Fig. XIV, the "soil" value, or value of future crops, is worth $\frac{10.00}{1.05^{15}} = \$4.80$, and *not \$10.00.*

What happens when a fire destroys a half-grown crop is that the date of harvest for future crops is moved forward by a period equal to what the burned crop lacked of maturity. Fig. XIV indicates that the discounted value of the burned crop is really greater than the value found in § 126 by deducting full soil value S, and is in fact:

$$\frac{Y}{1.0x^{n-a}} - \frac{\frac{e}{.0x}(1.0x^{n-a} - 1)}{1.0x^{n-a}}$$

or the discounted *net* income from the crop. This can be expressed as:

$$\frac{Y + E}{1.0x^{n-a}} - E$$

Subtracting this *true crop value* from total value gives a value for soil of but

$$\frac{S}{1.0x^{n-a}}$$

This separation may be tabulated for the example in § 126 as follows:

Separation of value of an existing crop of timber 25 years old from value of subsequent or future crops, or "soil" value.

	When timber remains on the land	When timber is removed from the land
Value of property	\$134.52	\$134.52
Value of timber	131.90	124.52
Residual "soil" value ...	2.62	10.00

Here is a difference of \$7.38 in "soil" value. If this crop is burned is the damage \$131.90 or \$124.52 and who stands to lose the \$7.38? Fig. XIV should make it clear that the deduction of the full "soil" value reduces the supposed damage to the part destroyed or crop by theoretically *benefiting the owner* by increas-

ing the capital or present value of income from the subsequent crops. This transfer or shift of the value $7.38 from standing crop to future crop exactly equals the difference in the value of having $10.00 to use now, or having to wait 25 years for it. The $10.00 is the same sum but does not have the same capital value. The $7.38 represents discounted interest on $10.00 for 25 years, or the value of the use of the land for that period.

This "rent" of land *represents no cash outlay, is not a future cost,* and hence *does not reduce the value of the property as do true future costs.* The item is a matter of settlement between the plaintiff and defendant as to what constitutes the true *residual value* of the property, and the *net loss.* If the plaintiff has been benefited by the fire to the extent of $7.38 by release of soil, he can afford to allow the defendant to deduct this sum from the true crop value, otherwise he cannot.

In cases where appraisals of young timber are excessive and unjust, as sometimes has happened in suits against railroads, there is a distinctly unfair advantage to the owner in this release of soil, permitting the prompt production of a second crop to be subsequently destroyed and paid for. This hardly justifies the method.

When the crop is actually destroyed, the *possibility* exists that the owner can start the new crop at once. The correct method of appraisal of damage is therefore in this case *to first deduct the full soil value* as in § 126 to get the value of the crop, and then to *separately determine the damage to this residual "soil" value.* If this is not done, it would be better to value the damage to the crop irrespective of any such deduction for soil, as $\frac{Y+E}{1.0x^{n-a}} - E$ or in the above example, as $131.90 instead of $124.52.

128. Additional Damage to Land. — These remaining items of damage to the property as explained in § 123 are equal to any increase in cost of establishment or of production of a new crop, plus any additional or unavoidable loss in its prospective value. If the appraised cost of establishment and maintenance and prospective income of the new crop is identical with that normally assumed, there is no damage other than the value of the part destroyed, i. e. the standing timber, except what may affect the value of the area not damaged. The factors of additional damage to the burned area itself are:

1. Cost of removal of debris left by the fire, including cutting back of sprouts, clearing up of dead material and reduction of the fire risk to normal. For the latter expense may be substituted the cost of an intensified system of fire protection over such period as is required for natural processes to remove the excessive hazard. (See 3 below.)
2. Cost of reëstablishment of stand. Where seed trees are normally depended on and have been destroyed, the additional cost of re-stocking by planting is a measure of the damage.
3. Cost of tending and protecting the crop. Any additional cost required to overcome adverse conditions caused by the fire either in fire hazard or in securing a crop of the same species as normally would be secured.

   If these three elements of increased cost are sufficient to secure a crop of equal value and in the same period of time as would have occurred in the absence of damage, the sum of these costs added to the value of the young timber gives the total loss of property value.

   If the crop value cannot be restored by these measures the appraisal may rest upon the loss in value to this new crop. This will be due to
4. Delay in securing reproduction. Severe fires often result in such delays for periods up to 20 years.
5. Substitution of inferior species. The loss is measured by the difference in capital value of the resultant crops.
6. Deterioration of the site resulting in lower yields of the established species.

129. Additional Costs of Reëstablishing the New Crop. — If the fire-killed material has a value on the stump, which means that it can be removed for less than it will bring on the market, this item serves to reduce the damages. It must be possible not only to readily market this material but to organize and complete successfully the operation of cleaning it up. If the appraised cost of this operation exceeds the value of the salvage and the renovation of the area is necessary to avoid fire risk or secure normal reproduction, the net cost is a direct measurement of damage. The same rule applies to an unusual cost such as planting.

The normal cost of slash disposal if considered as an initial cost

in appraising the value of the standing timber cannot be included again in damages to the property when timber is burned.

Let C = Total normal cost of establishment of crop.
C' = Cost of same resulting from destruction of immature crop.

Then, this element of damage is:

$$D = C' - C$$

e. g. In the above problem, the dead poles may be sold for cordwood at a profit of 50 cents per cord, and the area will yield 25 cords, or $12.50 per acre. The cost of disposing of the remaining slash and tops is $5.00 per acre. From this source, the salvage value nets $7.50 which is deducted from damages. Any excess of cost over value would have been added. If the dead timber has no net value, the cost of disposal or $5.00 constitutes the damage.

If the area was originally planted at a cost of $15.00, and can be replanted at like expense, no damages are added for planting. If the cost of planting has been increased, the difference only would be added. If reproduction was from seed trees without cost, the cost of planting, $15.00, constitutes the damage. This is true where seed trees are destroyed by fire.

130. Additional Costs of Protection. — If the increased cost will take the form of more intensive fire protection, the period over which this will endure must be estimated. Let the resultant annual cost be e', the normal cost e, and the period a. Then the capital value of this element of damage would be:

$$D = \frac{e' - e}{.0x}\left(\frac{1.0x^a - 1}{1.0x^a}\right)$$

$$= \frac{e' - e}{.0x} - \frac{\dfrac{e' - e}{.0x}}{1.0x^a}$$

E. g. If in the above case the slash is not cleared up but instead a more intensive patrol is constituted so that fire protection for 10 years will cost 50 cents additional per year, the extra cost will be:

$$\frac{.50}{.055} - \frac{\dfrac{.50}{.055}}{1.055^{10}} = 9.09 - \frac{9.09}{1.7081} = \$5.32$$

as compared with the $5.00 cost of clearing up the débris. Similar comparisons have often been made in favoring the substitution of protection for the cost of slash disposal, but such substitution is dangerous for the reason that the amount of additional fire protection seldom serves to reduce the hazard to a point equal to that secured by the elimination of slash, hence the actual *rate earned* will probably suffer by loss of income through future damage.

Where both of the above elements appear in the case of total destruction of young or immature stands, the damage is:

$$D = \left[\frac{Y + S + \frac{c}{.0x}}{1.0x^{n-a}} - \left(S + \frac{e}{.0x}\right)\right] + \left[(C' - C) + \left(\frac{e' - e}{.0x} - \frac{\frac{c' - e}{.0x}}{1.0x^{a}}\right)\right]$$

(Loss to standing timber) (Loss to soil, i. e. future crops)

131. Damage to Soil Appraised by Estimating Damage to Succeeding Crop. — The conception that damages to soil can be appraised on the basis of physical injury is erroneous (§ 126). The only adequate basis for valuing such damage is to measure the reduction in net income which can be attributed to the damage. If the value of the next crop can be restored to normal by cultural costs, this suffices, otherwise it is merely a make-shift. A fire may destroy a stand of northern hardwoods and replaces this stand with fire-cherry. The soil remains practically intact with slight loss of fertility, yet its forest value suffers severely. In case a fire is followed by reproduction of a valuable species such as Douglas Fir, this soil value might be increased rather than diminished. Aspen following a burn would improve the value of the soil if the discounted returns from this species were higher than from those formerly occupying the area. Where soil is actually destroyed by being consumed or washed away, loss of value is measured not by this physical damage but is based on the fact that the soil no longer is able to produce a future income equal to its former yield.

There can be but one rule, therefore, in appraising such soil

damage as is incapable of restoration through incurring reasonable costs, and that is to ascertain the resultant loss in value of the future timber crop. This process is made difficult by the problem of choosing the rate of interest to use in discounting these losses. If x or rate earned is used, the basic or undamaged value is equal to the present appraised value or cost of the soil (§ 120) and this is the only practical method when soil has been properly appraised. E. g. In the example cited in § 126 the value of the crop is $360.00 and of the thinnings, prolonged to 50 years, respectively $85.40 and $72.94, or a total value of $518.34. The soil value or cost is $10.00.

A loss of $145.40, or 28 per cent of the value of the new crop, would wipe out this soil value, since

$$.28(518.34) = 145.40, \text{ or}$$

$$518.34 - 372.94 = 145.40$$

Then $$\frac{Y - Y'}{1.0x^n} = \frac{518.34 - 372.94}{1.05^{50}} = \frac{145.40}{14.54} = \$10.00$$

The reasons for treating this loss as a margin are those given in § 125.

A greater per cent of loss to the next crop causes the capital value of this loss or the present damage to exceed this cost of the soil or the appraised value (§ 120). It is doubtful whether any greater damage can ever be claimed than that equal to the total value of the property, properly appraised. A damage to this future crop of 50 per cent gives a present damage to soil of $17.83, or $7.83 in excess of its value. (But see § 123.)

132. Partial Damage to Immature Timber. — Partial damage to young or immature timber takes one of two forms. Either a portion of the trees are killed outright or the growth of surviving trees is checked and their ultimate value reduced by reason of fire scars or other injury.

The first case is best handled by determining the area in acres which represents the timber destroyed, and treating this by the method used for total destruction (§§ 126-130). The area can either be mapped out or estimated from the survey as a per cent of the total area of the burn. Where the dead trees are interspersed with live timber and constitute the smaller and weaker specimens it may happen that the ultimate damage to the crop is very small unless the survivors are injured, since a progressive loss of numbers is natural to the development of all even-aged stands.

Where the surviving stand is evenly dispersed but too scattered to form a full crop of standard quality at maturity, or where damage is inflicted in the form of scars and subsequent rot, the loss which will result to the mature crop must first be approximated. This is best done by means of a probable percentage loss of stumpage value (§ 125).

The appraisal of this damage in the present year will be based on the principle of marginal damage already covered in § 125. The stumpage value, though applicable to the young timber at the future date when it matures, is taken as the present price of stumpage (§ 121). This price so set for the future year n is discounted to get present gross value of the immature stand, in any year a by $\frac{Y}{1.0x^{n-a}}$. Since future expenses cancel, the difference or *loss* in value is directly measured by subtracting the discounted residual value of the timber $\frac{Y'}{1.0x^{n-a}}$

Thus $$D = \frac{Y - Y'}{1.0x^{n-a}}$$ (See also § 131)

If the *value before and after damage* is wanted for purposes of evidence, the discounted expenses are deducted from each of the above values.

E. g. In the example given in § 125 the value of the revenue from the crop is reduced 40 per cent because of the fire, according to the appraisal of damage. This gives a damage of

$$\frac{.40(518.34)}{1.055^{25}} = \frac{207.33}{3.8134} = \$54.36$$

133. **Damage to Many-aged Stands.** — In valuing the damage done to stands or portions of a forest which are uneven in age, composed of two or more age classes of timber, the choice lies between treating the stand as a single many-aged unit or in endeavoring to separate it into even-aged stands each of which in theory occupies its true proportion in area of the whole. This choice must rest on the character of the stand and the species composing it. If the second alternative is used, the separate elements are appraised by the methods described for even-aged stands.

When a forest is composed of shade enduring species and is managed on the so-called selection plan of scattered cuttings, not

taking any trees below a fairly high diameter limit unless for the improvement of the surrounding stand or because they are defective and inferior, the reproduction occupies successively the openings established in the stand and in course of time there is present on every portion of the area an almost complete series of ages scattered singly or in groups in such a manner that it is practically impossible to make a physical separation of these age classes on the basis of the areas occupied exclusively by separate age groups.

Due to the plan of conservative cutting pursued and the leaving of all trees below the limiting diameter for cutting, there is certain to be in such a forest considerable merchantable material which would not ordinarily be cut. This gives rise to a situation where, in case a fire destroys the stand, the tendency is to appraise all the fire-killed material on the basis of its merchantable value before and after the damage, ignoring both the value of the young growth and that of the forest as a going concern based on annual income.

E. g. A stand of spruce and fir in Maine is cut to a diameter of 10 inches on a 10-year cutting cycle which yields 4 cords per cut, or 4/10 cords per acre annually. Stumpage values are $10.00 per cord, and annual charges 50 cents per acre. In total destruction by fire, the timber below as well as above 10 inches is killed. If this stand below 10 inches will also cut 4 cords per acre, which constitutes the growing stock, the total merchantable value of the stock is $40.00 plus the accumulating stock above 10 inches, or in the 10th year $80.00 per acre. The damage would be this value minus whatever salvage value the wood has from the dead trees, this depending on increased cost of logging and disruption of logging operations. Putting this extra cost at $1.00 per cord, the net loss or damage would be:

For year after cutting	$40.00 — 36.00 = 4.00
For 5th year after cutting	$60.00 — 54.00 = 6.00
For 10th year after cutting, or just before next cutting	$80.00 — 72.00 = 8.00

Not only is this young timber below 10 inches cut before it is intended but the seedlings and saplings are destroyed. In the case of Low vs. N. Y. Central and Hudson River R. R. an arbitrary value of $1.00 per acre for such young growth, plus 50 cents for soil, was named by one witness, who claimed that no one could

approximate said value except by guess. Such an appraisal would merely add $1.50 per acre to the above damage.

The loss in this case lies in the destruction of a going concern, in whole or in part, and should be appraised on the basis of loss to the value of the whole forest, and not to the merchantable timber destroyed (§ 112).

In valuing damages to even-aged stands it was emphasized that the value of the soil should be appraised at its present value and not on that of initial costs at some past period (§ 120). Where soil value cannot be separated, it is equally necessary for the same reasons to appraise the value of the entire forest unit, not on the basis of its initial or past cost but as it is at present. In such an appraisal, the value to the owner as a source of income must be the basis (§ 114). Not even market value can be substituted if shown to be inadequate.

The loss in such a forest is best shown by appraising the value of the loss of income. Since this income is on an annual basis it might seem that the problem of choosing the rate of interest is simplified. But this is not so. A total loss of the forest destroys all net income. If this has a value of r annually, the damage, D, is

$$D = \frac{r}{.0p}$$

This is reduced by salvage of dead timber.

Assuming a rate of 5 per cent in the above example, the forest on the basis of annual income is worth per acre, with no charge for reëstablishment of crop:

$$V_o = \frac{.4 \times 10.00 - .50}{.05} = \$70.00$$

and contains on an average $4 + 2 = 6$ cords per acre, with a salvage value of $9.00 per cord, or $54.00. The damage is $70.00 — 54.00 = $16.00. If 4 per cent is used to capitalize this value, then,

$$V_o = \frac{4.00 - .50}{.04} = \$87.50$$

$$D = 87.50 - 54.00 = \$33.50,$$

a damage twice as great, since the values of young growth and security of the investment are recognized by a *lower rate of discount*. A low rate used to capitalize forest income indicates an

established forest industry and generally accepted values in forestry. A high rate indicates a low regard by the public for such investments and a high risk. Where the rate of discount is relatively high it is probable that this rate will have the effect of destroying the value of the immature timber in such appraisals, thus reflecting not the values in forestry but those now pertaining to forest exploitation.

The value so determined is for the acreage burned. There remains as usual the valuation of the loss to the remaining forest area or estate as a whole, due to reduction in stumpage values or net income. The disruption of operations not only to the forest but to the industries dependent on this forest must not be overlooked in appraising damages. Failure of supply might mean loss of these industries and damage greatly exceeding the loss of the timber itself. These losses can seldom be defined with sufficient exactness to form a basis of damages.

Where a forest is cut over in a cycle of m years, and certain stands are burned whose normal period for cutting is known, these stands may be valued more exactly by recognizing these factors.

When the per cent for capitalizing the value of income has been determined, the capital value of a stand to be cut every 10 years or m years, the first cutting falling m years from now, will be

$$V_0 = \frac{Y}{1.0p^m - 1} - \frac{e}{.0p} \qquad (\S\ 57\text{—V and VI})$$

In the example given,

$$V_0 = \frac{40.00}{1.05^{10} - 1} - \frac{.50}{.05}$$
$$= \frac{40.00}{.6289} - 10.00$$
$$= \$63.60 - 10.00 = \$53.60$$

In the year m just before cutting, the value is:

$$V_m = Y + \frac{Y}{1.0p^m - 1} - \frac{e}{.0p} \qquad (\S\ 57\text{—VIII})$$
$$= 40.00 + \frac{40.00}{1.05^{10} - 1} - \frac{.50}{.05}$$
$$= \$93.60$$

For any year a between, it is

$$V_a = \frac{Y(1.0p^a)}{1.0p^m - 1} - \frac{e}{.0p} \qquad (\S\ 57\text{—VII})$$

$$= \frac{40.00(1.05^a)}{1.05^{10} - 1} - \frac{.50}{.05}$$

Hence, in 5th year, it is

$$V_5 = \frac{40.00(1.05^5)}{1.05^{10} - 1} - \frac{.50}{.05}$$

$$= \$81.17 - 10.00 = \$71.17$$

In the same way, at 10 years, or just before the next cut, it is

$$V_{10} = \frac{40.00(1.05^{10})}{1.05^{10} - 1} - \frac{.50}{.05} = \$93.60$$

In this case the damage after deducting salvage is:

In year after cutting	$\$53.60 - 36.00 = \$17.60$
In 5th year	$\$71.17 - 54.00 = \$17.17$
In 10th year	$\$93.60 - 72.00 = \$21.60$

on the basis of the assumed rate of growth.

The damage to a 4 per cent investment is proportionately heavier. Where the crops are irregular in time, it is best to use the method of segregating them on the basis of area, dealing with each immature age class or cut as an even-aged stand.

Since by the above method the damage is based on the value of the property which includes soil, it covers any damage to the soil as well as the timber. If the soil, or prospect for future crops after the fire, is worth anything, this should be credited as salvage would be, in reducing the damages. Many of the sites occupied by slow growing species show a very low value, and when soil is organic in composition and is burned away it is worthless.

By the above means, the value of young immature timber may be determined on a basis of reasonable certainty in such a forest. This value should never be neglected.

134. Damage to Watersheds. — The damage inflicted by the denudation of watersheds is not confined to the soil itself but is spread over dependent territory. These additional or indirect damages can sometimes be measured by the cost of restoring the damage done by floods resulting from such denudation, provided it

can be shown that such floods were a direct result of the denudation. The same is true for destruction by avalanches, or the silting up of reservoirs following overgrazing. The value of the property destroyed may be substituted where cost of restoration is impracticable.

While enormous damage may be traced to this source, it is seldom possible to recover damages by civil action. The difficulty lies in establishing with certainty the connection between the damage and acts of a responsible party which are in violation of equities, and in allocating the proper proportion of responsibility on the defendant. Where owners of property having a value as watershed protection permit any grazing or timber cutting upon it, they should insert in the contract a value agreed upon for destruction of protective cover in case of fire.*

Damage to property by reason of proved negligence and violation of statutes by offenders, thus directly or indirectly causing such damage, may always be made the subject of testimony regardless of the method used by the witness in arriving at his appraisal, and where the damage is apparent and real, as in such cases, the fact that no certain method is available to determine the value does not act to prevent such an appraisal by the best judgment of those competent to make it.

135. **Damage to Aesthetic and Recreational Values.**— It is important in appraising damages to this class of values to base the damage upon either loss of income or loss in market value of the property as a whole. On the one hand, the value of the parts destroyed should never be accepted since this is usually wholly inadequate as a measure of the damage to the property. On the other, exaggerated estimates of value based on sentimental grounds cannot be considered. Where the property is developed as a commercial resort, loss of income which can actually be demonstrated is the best basis. Where the estate is private, a fair market value based on similar estates, and the loss to this value, will serve. The value of the land in this case will rest on the purpose for which it was purchased, or developed, and not on forestry or farm production.

*In the case of Chicago, Milwaukee, and St. Paul R. R. vs. United States of America, the jury allowed the sum of $5,500 for damages to the channel of the river due to erosion and silting caused by the fire.

136. **Punitive Damages.** — Civil damages are properly confined to actual loss in value. Criminal liability for violation of statutes carries with it a penalty of fine or imprisonment. In an effort to protect public property in timber, statutes are sometimes passed prescribing so-called punitive damages. In New York State, the penalty for destruction of State timber is fixed at $10.00 per tree. No pretense is made that this is the value of the tree, the amount being in the form of a fine. Such instances do not constitute true civil damages and are not a proper measure of damage.

CHAPTER XV

THE BASIS OF STUMPAGE VALUES

137. **Definition of Stumpage Value.** — Stumpage is the price paid by a purchaser for timber standing in the tree, to be cut and removed by him. Stumpage value is the value of standing timber for the purpose of cutting and removal.

The price of stumpage may be based on immediate removal, as when payments are made currently on the basis of the scale of logs cut. This condition, sometimes termed a royalty price, gives the highest value to stumpage (§ 101). Where large tracts are purchased outright on which logging cannot be completed for a long period, stumpage value is severely discounted from this maximum to allow the purchaser to meet the hazards of taxation, fire and other losses, and change in markets and prices, and to earn a fair rate of interest on the capital invested in stumpage for the period. Further deduction is required if a tract of suitable size for operation must be assembled from smaller holdings (§ 100). Since operating prices are the basis from which such further deduction must be made, the discussion of appraisal of stumpage prices in Chapters XVI and XVII will be confined to the value for immediate sale.

Stumpage value does not include the value which trees may have for shade or ornamental purposes, nor the capital or expectation value of immature trees, nor any element of value attached to the whole property by reason of the existence of these trees independent of their value for cutting and removal.

Trees are a part of the real estate on which they stand, just as are houses, but stumpage value is confined to the value of the "part," that is, the trees only, for the purpose of severing them from the soil.

This conception of the separate value of the timber from the soil carries with it the idea that the only change to be expected before cutting is that of price which agrees with the conception of timber as a mine. This idea is strengthened, for virgin timber, by the fact that whatever gain in volume occurs by reason of growth is apt to be offset by losses natural to overmature timber. Little is known about the relative rate of these changes and it is roughly estimated that the purchaser will be able to cut out what he paid for if the estimate is conservatively accurate.

Throughout the extensive lumbering operations that have marked the exploitation of the original forests in this country, the value of the merchantable timber has been considered by the purchaser as practically identical with that of the real estate, the soil not having any value separate from that of the timber.

In logging, the practice still is to remove all timber which has at the time any stumpage value, and the residual property including soil, young timber and species not at the time merchantable, is often considered as not having any value. This property was either abandoned for taxes, sold to speculators for its possible value as farm land, or held largely through inability to find a purchaser.

With the increase in the value of wood products, stumpage values have increased, making profitable the logging of smaller trees, the closer utilization of tops, and the cutting of inferior species, which thus come to have a stumpage value. Even at this stage, no forest value is placed on timber still too small to cut, or on soil, though the soil may be valued for an entirely different purpose than that of timber production. These ideas still prevail and to a large extent determine market values for the soil and young growth on land bearing merchantable timber which has a stumpage value. Market values for forest property as such will diverge from stumpage values only in so far as growth is recognized as a factor which creates value. Until forests are recognized as productive of timber crops, the value of the part, that is, stumpage value, will continue to be taken as the value of the whole, with corresponding loss to the owner.

138 **Physical Basis for Stumpage Values.** — Stumpage is always sold on the basis that it is to be converted into certain definite classes of products such as timber, cross ties, posts, pulpwood or firewood. These products are the object of purchase and the value of the stumpage on any tract is determined by the kind of products it will yield and the quantity or number of units or pieces of each separate kind and grade for which a separate price may be established.

The stumpage value of a given tract of timber could be directly calculated by multiplying the quantity of merchantable products which it contains by the price quoted for one unit, such as a standard cross tie or 1000 board feet of sawed timber. But neither the purchaser nor the owner can ordinarily tell how much value

can be gotten from the timber because of the difficulties of measuring these products while still in the tree, and the prohibitive cost of doing so for every tree on a large area. If the owner could wait for his money until the trees were cut and converted into the intended products, settlement would be on a definite basis. This is often done with cross ties or other piece products which are fashioned into final form in the woods, and may be the basis for timber as well on small operations where the set up is in or near the timber.

Where logs are cut, to be taken off the property to mills at some distance, the basis for payment must be measurement in the log before shipment. This requires scaling the contents in board feet by a log rule and introduces the factor of overrun or underrun, which is the difference, surplus or deficit, in the quantity of lumber manufactured over that measured in scaling the logs by a given rule and according to prevailing or prescribed customs.

The overrun is always expressed as a percentage of the log scale. It is due to the impossibility of standardizing sawing practice, hence formulating any fixed log rule which will agree with this practice,* and to the fact that most log rules in use were based on a lower standard of utilization than that which now prevails. Where log scale is the basis of payment, it is the basis also of timber estimates and of stumpage prices. The stumpage is thus paid for on the basis of actual scaled volume of trees after falling and bucking into logs, though, as in all cases, the value is that of the contents in the standing tree.

Where timber is purchased to hold either as a speculation or for a large-sized operation, the logging and scaling is in turn too long deferred to be acceptable as a basis of payment. In this case, an estimate of what the stand will probably cut must be made, the cost and accuracy of which is influenced by the prospective value of the timber, the size of the area, and the time available for the work.†

The value of the timber is then calculated by fixing the price per unit of estimated stand which multiplied by the estimate gives the total value of the timber, and often of the whole property when purchased outright.

* Chapman's Forest Mensuration, Chapter V.

† Chapman's Forest Mensuration, Chapters XVIII-XXI.

Purchasers usually prefer to buy timber lands or standing timber from small holders by offering a lump sum in cash, not expressed in terms of unit prices for products. This may result in loss to the owner through ignorance as to the quantity sold. No sale can have a satisfactory basis other than a careful physical estimate of the quantities of each class of products in the standing timber, whose sale is desired.

139. Economic Basis of Stumpage Values. — The value of stumpage is dependent on that of the products into which the timber will be manufactured. Stumpage value is what remains after deducting all future intervening costs and profit from the value of the finished product. In this it is similar to land, which is one step further removed from the value of finished products, but whose value is obtained by a similar process, § 30.

The stumpage price at which a given body of timber is sold will be affected by the following six separate factors or considerations in addition to the value of the products, namely:

1. Relative accessibility and cost of logging, or the appraised value to the purchaser which allows him a margin for profit and risk;
2. Cost plus carrying charges, or the appraised value to the seller which allows him a margin for gain;
3. Relative monopoly strength of the two parties, and their relative knowledge of values;
4. Basis of sale, whether on royalty or outright purchase;
5. Market prices of similar timber in vicinity;
6. Experience of operators on basis of past prices.

1. Timber is purchased for the purpose of making a profit over operating costs and all other expenses of putting it on the market. Since these costs are constantly being redetermined in current operations, the probability of a margin of profit existing for any given operation can be tested by a careful appraisal in which all factors of cost are estimated and compared with the current prices of the product. The chances of error or risk of loss lie in future changes in market prices for the product due to fluctuating demand, which is specially prevalent in markets for wood products; changes in future costs of operation; and errors in the appraisal of actual costs and income on present basis, due to inability to properly measure the quantity and quality of products available or the cost of logging, manufacturing and selling them.

The purchaser must be protected against these risks by basing the prices of the product on an average of several years' past prices instead of those of the current year. The cost of the operation must be based on the physical factors pertaining to the body of timber to be purchased, which will not be the same as for any other body and require appraisal on the ground on the basis of careful estimates and the determination of the boundaries of the area and quantity of timber to be logged as well as the conditions affecting the removal of the timber. After all possible factors have been considered, a further margin must be allowed for probable loss due to unpredictable factors such as unusual climatic conditions causing losses or higher costs, and unexpected economic disturbances affecting sale values or costs. This margin is the purchaser's factor of safety, permitting him to reasonably expect a profit.

It is of equal advantage to the seller to know these factors. Too high a stumpage price, especially when payment is concurrent with logging, usually means the bankruptcy of the operators, a broken contract and a half completed operation, the depreciated residual value of which entails much loss, not to mention the discouragement of future purchasers. The best interest of the owner lies in giving the purchaser a fair chance to make a reasonable profit.

2. Past cost plus carrying charges has very little weight in determining a seller's price, but future cost will influence a purchaser if the latter expects to have to carry the timber for a period before cutting it. Speculative holders of timber may appraise the current value of their stumpage on the basis of past purchase prices plus interest and taxes at any specific per cent of compound interest which they may feel entitled to, but they are powerless to obtain prices on any such basis. The pressure on the purchaser for operating profit is far more insistent and powerful an influence. The owner in theory had the same alternative of profit in operating, though in practice he may be unable to log it due to economic disability (3). If stumpage values increase it will be because the margin available for stumpage has changed for the better and not because of the length of the period over which it has been held.

Hence operators finally determine the prices of stumpage rather than either speculative owners or growers of timber. What the

operator can pay is in turn determined by consumers of timber in their effort to obtain the marginal or final quantity desired at any one time (§ 30), and as lumber is a commodity which is not indispensable, the consumer's tendency is to greatly curtail its use in periods of financial stringency.

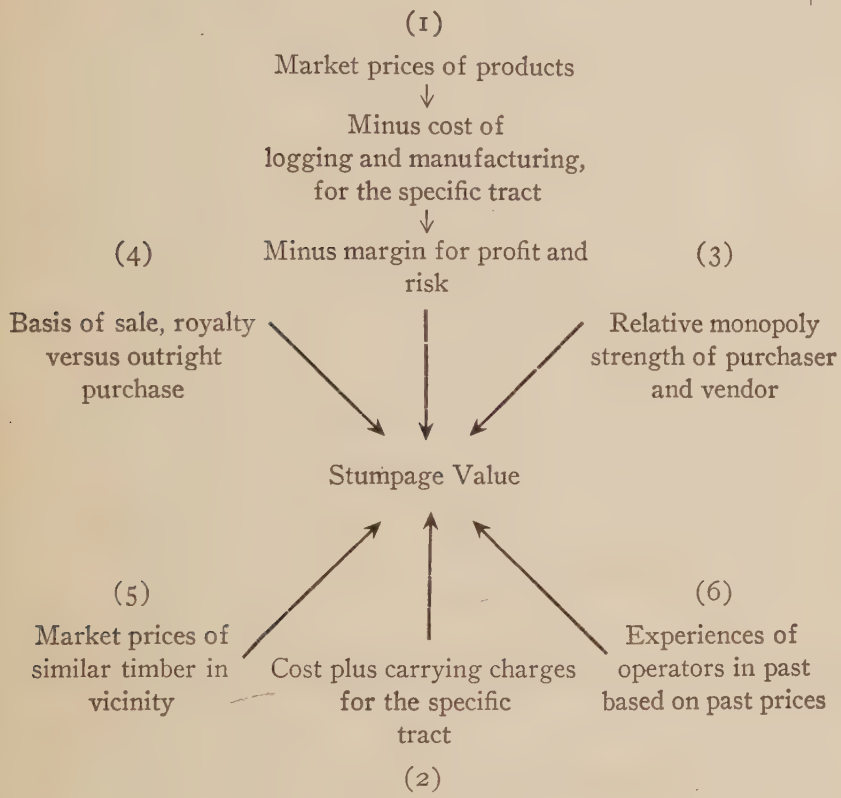
3. Relative monopoly strength of purchaser and seller is approximately equal only if both are potential operators, for timber can yield no ultimate revenue except through operation. In this case they presumably have equivalent knowledge of value and may be fairly well balanced as to financial resources, on which depends the ability to wait or withhold which is the essence of monopoly strength (§ 28). On the contrary, non-operators or speculative holders may lack the ability or knowledge of the business, the capital to undertake it and sufficient timber to form the basis of the operation; all of which diminishes their monopoly strength and the price which they can obtain for their stumpage.

4. Where timber is purchased outright, incidental to an operation extending over a period which may be twenty to thirty years, its price is diminished by the cost of purchase and assembling of the larger body of timber and by the period which must elapse before cutting (§ 127). Where it is to be resold, the cost of this sale is an additional element of expense. Appraisals therefore give quite different values when based on sale of stumpage to be paid for as cut and when used for purchase of timber or forest land for future sale or operation.

5. Market values of similar timber in the vicinity are more apt to exert an influence on non-operating holders of small tracts than upon larger owners. For many such small owners, quoted or market prices for stumpage is all the information they possess as to its value, and standard prices which represent a reasonable minimum value for these small tracts are easily maintained by a single large operator in the absence of competitive buying, and regardless of the relative value of different blocks so purchased.

6. Where timber is held strongly by well-informed owners, purchasers may be inclined to bid too high in competition, or to pay prices for stumpage which do not permit of a fair operating profit. The actual experience of such operators exercises a powerful influence on subsequent prices, since neither the seller nor the purchaser is benefited in the long run by the bankruptcy of the operator and failure to complete the logging of the area.

These six factors influencing stumpage values may be shown by the following chart.


(1)
Market prices of products
Minus cost of logging and manufacturing, for the specific tract
(4)
Minus margin for profit and risk
(3)
Basis of sale, royalty versus outright purchase
Relative monopoly strength of purchaser and vendor
Stumpage Value
(5)
Market prices of similar timber in vicinity
Cost plus carrying charges for the specific tract
(6)
Experiences of operators in past based on past prices
(2)

140. Changes in Stumpage Values. — With some exceptions stumpage values have shown an upward tendency in every forest region from the earliest logging down to the present. Part of this increase represents merely decreased purchasing power of the dollar. The remainder is caused by the fact that prices for wood products have increased relatively faster than the average for other commodities and faster than have the costs of logging and manufacture. This increase is due primarily to the growing relative scarcity of wood as a commodity. As wood becomes

scarce and its price increases, a greater margin is available for logging and manufacturing costs, in an effort to reach timber

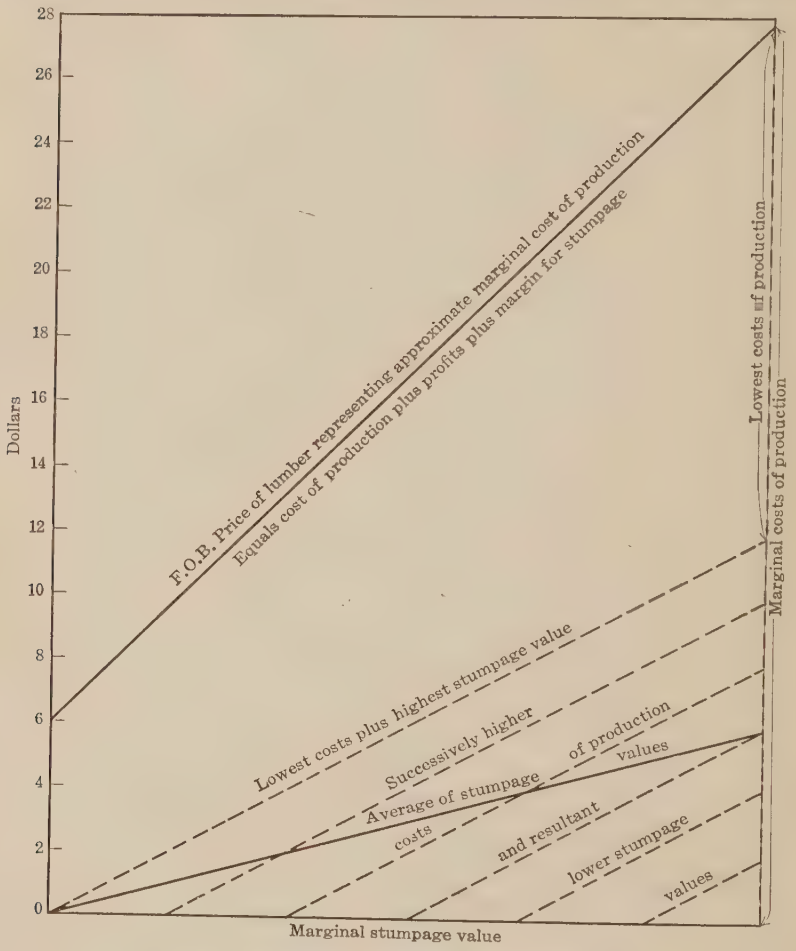


FIG. XV.—Relation of average stumpage prices for a region compared with increase in stumpage prices on a given tract within this region, showing retardation of the increase in this average value due to extension of marginal cost to include less accessible stumpage.

formerly inaccessible, hence the *ultimate stumpage value of the most inaccessible timber is at all times zero,* but the limit of accessibility is constantly being crowded back. With this increasing marginal cost (§ 30) the stumpage value of any timber

remaining on the more accessible and less expensive operations increases proportionately as long as the market remains, which means, as long as timber can yet be obtained in quantities and with certainty sufficient to form a reliable working basis for wood-using industries and wood uses in all lines. With the exhaustion of available supplies beyond this point, and consequent emigration or disruption of wood-using industries, wood prices locally will suffer because the residual use is in less intensive industry and for less valuable products. For a given relatively accessible tract, all other local conditions remaining the same, the value of stumpage increases more rapidly than the average value of all the stumpage in the region, since this average always includes a range of actual values beginning with zero and extending to the timber which commands the highest margin of value. These relations are shown in Fig. XV.

Fig. XV is purely diagrammatic. The actual trend of stumpage prices will be neither regular nor will it conform rigidly to the theoretical relation between lumber prices and costs.

Lumber prices are violently erratic, passing from high peaks to depressions more suddenly than that of most other commodities. By contrast, stumpage prices maintain levels without appreciable change for considerable periods and may then change fairly rapidly for a short time to settle at a new level, which is almost always higher than the former one.

These phenomena are explained by the above figure. Even if stumpage prices were in each instance determined by direct appraisal based on lumber prices, the current price of lumber would furnish a fair basis only for small sales for immediate operation,—and in practice, such sales do show the greatest fluctuations in stumpage values. For large sales or for timber to be held for a period of years, even in appraisals, past lumber prices are averaged as a basis. In theory, the prices to be received over the entire future period are the real basis of present value, and this future average price, embracing both high and low of future fluctuations of price, will result mathematically in very slow changes in stumpage values.

Even then, if it were possible to determine market value or selling prices for stumpage on the basis of appraisals of average future lumber prices, there would result a constant more or less gradual change in stumpage prices. But this influence is only

one out of the six potential factors which influence such sales. Of the remainder, the one which exerts the greatest influence is the market prices paid for other timber within the same region or district and which owners of timberlands tend to accept as indicative of value. As a result, market prices for stumpage tend to remain fairly stationary for a period while the forces tending to increase value are accumulating an economic pressure which finally overcomes this resistance rather suddenly, producing an upward jump in values. Similar tendencies are revealed in the course of land values.

The further removed from immediate operation the purchases lie, as for instance in assembling a large tract for future operation or holding, the greater is this cumulative resistance to change. This steadying influence is increased by the fact that in times of high lumber prices purchasers tend to allow themselves a much larger margin for profit and risk, and when prices are depressed, are encouraged to buy stumpage on a very narrow margin. As a result, stumpage bought for large operations has practically never shown a recession in price despite recurrent stagnation. This cannot be said of stumpage bought for immediate operations in small sales. Prices of stumpage in such sales are far more sensitive, and after the peak during the war sometimes dropped to somewhat lower values.

As in the case of land, the value of stumpage is based on the price at which sales can be made in sufficient volume to supply existing demand from existing supply.

141. The Basis of Appraisal. — An appraisal is made either by a purchaser or a seller, for immediate cutting or to constitute a holding for continuous or future operation or sale.

An owner offering stumpage for sale, to be paid for as cut, should appraise the stumpage value in a manner to indicate what price a purchaser can afford to pay for it (1) and still leave a margin for profit and risk sufficient to justify the enterprise. This requires the same consideration of the price of the products, the cost of operation and the nature of the risks assumed as the purchaser himself would wish to make. In addition, such conditions of appraisal require special consideration of the market price of similar timber in the vicinity as revealed by recent sales (5), and of the experience of operators in the past based on past

stumpage prices (6), paying very little if any attention to the cost of growing or carrying this timber.

Where timber is bought to hold, the purchaser has more weight in determining the price. In this case the market value will depend, instead, upon the discount necessary (4) from the royalty value (1) in order to protect the purchaser's holdings, and his monopoly strength or advantage in assembling his holdings (3) so as to be the only large purchaser in a given area.

Neither seller nor purchaser, under either of the above conditions of sale, can rely too much upon the indication of other sales (5) without risk of serious loss, for the reason that such prices may have been unduly influenced by the relative strength of the parties (3) and that cost of logging will differ for each tract offered for sale (1) as will the quality of the timber. For these reasons, a careful calculation intended to indicate the residual price which an operator can pay for stumpage is a standard basis for all such appraisals. This appraised price, once indicated, can then be modified by items (3), (4), (5) or (6) according as the appraiser is a seller or purchaser and to accord with his own judgment, advantage or necessity.

Even the most careful appraisals based on (1) by two different parties will indicate different prices unless deliberate agreement could be reached in conference on every item. A sale, however, is a practical agreement on a price regardless of the factors entering into it, and may indicate value better than an appraisal.

142. Readjustment of Stumpage Values in Long Term Sales. — When stumpage is purchased outright no subsequent readjustments are necessary. Where a contract for purchase covers a long term of years, and the timber is paid for just previous or subsequent to cutting, future stumpage prices will require adjustments at stated intervals.

In such contracts the purchaser is relieved from all future costs of carrying stumpage including taxes, and from risk of loss to the value of the standing timber by fire, insects, or other agencies, which are borne by the owner. The purchaser would be affected by extensive losses of timber through decrease in volume on which to depreciate improvements. Severe losses may even endanger the stability of his business.

Where an owner is practicing forestry, timber should always

be sold on the royalty basis, retaining the land and control over the methods of cutting and the right to readjust stumpage prices. The cost of reëstablishment of the crop, including slash disposal, increased cost due to reduction in volume of cut, the felling of snags or other items, is always borne by the owner either directly or by reduction of stumpage price in consideration of extra cost incurred by the purchaser. Since the basis of sale with these exceptions is not subject to deductions required in outright purchases, stumpage prices on such sales may still exceed those of timber bought for future operation.

With changing conditions, stumpage values will tend to increase, and since the owner carries the timber and most of the risk, he is entitled to stumpage value readjusted on the same basis as for the initial sale. The difficulty lies in determining this value in the absence of freedom of action on the part of the purchaser to negotiate a future actual sale (5). The purchaser usually desires some definite basis which will be free from personal bias, since his investment is tied up in the sale and must be protected, hence his position is relatively weakened (3).

The period of readjustment may vary from three to five years. Two general methods are possible as a basis of readjustment: sale prices of lumber or reappraisal of stumpage price of the timber sold. Sale prices of lumber can be approximated from standard quotations at established markets or in trade journals. An agreed percentage of any increase shown in average sale prices for different specific grades, weighted according to a specific percentage, has the great merit of exactness, e. g. if sale prices advanced 50 per cent, stumpage price to advance in the same proportion.

Reappraisal of stumpage on the same tract at frequent intervals involves almost as great an expense as the original appraisal. It is the more accurate method but as no appraisal can be fully accurate it gives an opportunity for endless dispute, or in case the seller is sole arbiter, for great dissatisfaction. Yet it is now the accepted method for all long term sales in the U. S. Forest Service and certain purchasers have consistently endeavored to obtain advantage from such reappraisals by demanding lower stumpage prices. The history of stumpage prices warrants the general conclusion that for long term sales of large quantities of stumpage, the value

of this stumpage will not recede, and that the purchaser is safe in accepting a contract based on this premise. In general the purchaser has his own opportunity to appraise the value, and after securing a contract on competitive bids must live up to his original agreement or forfeit the contract.

143. Cost versus Value of Stumpage. — Carrying charges on stumpage (2) must be separated into actual costs, and interest. Interest is not a true cost but a return to capital (§ 24). It takes the form of a cost when the entrepreneur borrows money (§ 20), but the expediency of borrowing is a personal consideration. In general, investments should not be financed extensively on borrowed money when the returns are long deferred and the debt would accumulate at compound interest (§ 38). Annual costs include outlay for taxes and for protection against fire, theft and possibly insects. These costs do not accumulate rapidly (§ 84). Interest, except on borrowed money, is a profit, not a cost (§ 24). From the economic standpoint all interest earned by an investment is a profit, while on the books of a business all except the interest paid on loans is termed profit. Interest as a carrying charge on an owner's capital is an anomaly, and is merely a personal cost appraisal (§ 27) whose purpose is to find out how much cash profit would be required from the sale of stumpage in order to net a given per cent of compound interest (§ 49).

It is a very common practice for owners of cutover lands to compute these appraisals of cost value and then put them out as true costs of growing timber. By employing a per cent which applies to short term borrowing or to profits on industrial enterprises, and then by compounding this rate of interest for extravagantly long periods and calling the result the true cost of growing timber, it is sought to prove that timber cannot be grown by private enterprise. The fallacies lie in failure to distinguish between costs and profits, between borrowed capital and owners' investment, and between rates of profit as measured by simple and by compound interest (§ 76). To claim that an investor must earn 6 per cent compound interest for a period of 100 years is equivalent to admitting that this investor is not interested in any enterprise requiring 100 years for its completion, and hence demands the astounding returns of $339.31 for every dollar he

invests now in such an enterprise (§ 77). This is no different from the attitude of any reluctant investor in any other field, and it proves nothing regarding the attractiveness of forest investments.

Persons who are truly interested in forest investments will consider the total of true or actual costs without interest, and will then regard the net profit to be earned on the basis not of comparing the compound rate earned x with a similar rate of simple interest, but of considering the ratio of returns to investment or the accumulation of wealth represented by such an investment, the comparatively little attention it requires and the relative safety of the property from damage (§ 79).

The appraisal of cost value or the gauging of future required or desired profits by adding interest to true costs is only permissible in an investment which produces insufficient annual income to offset true costs. If the income meets the annual expense there is no accumulation of such costs beyond the original investment. If a profit is earned over and above these annual costs, it is accepted as the annual return, at whatever rate it represents in earnings, and is either kept as surplus or distributed as dividends. If the concern is so organized that it is on a going basis, with income being realized through the completion of the main process for which it is organized which in forestry is the sale of mature trees, there may be individual years in which no net income is earned, but this does not lead to any charging of interest as a cost. It is accepted as a loss for the year and the dividend is passed.

The cost of growing timber may, and when possible should, be made an integral part of the annual costs of a going concern, whether primarily engaged in lumbering or solely in forest production. Such costs will form a comparatively small item in any enterprise connected with milling, which is in condition to perpetuate its cut (§ 82).

Against this cost can be offset the charge for depletion of timber (§ 88), which may be sufficient to cancel it, indicating that it is cheaper to grow the timber than not to do so.

E. g. A lumber company in the southern pine belt has an annual cut of 90,000,000 board feet from virgin timber which is not increasing in volume. They own 300,000 acres of land with an average stand of 12,000 board feet per acre, or a total of 3,600,000,000 board feet. At $5.00 per thousand, depletion is

$450,000 per year, and in 40 years the tract will be cut out. Annual fires are allowed to burn, destroying all reproduction. When the operation closes, the plant which represents several million dollars investment will have only a wrecking value; the town, which contains 4,000 people, will be practically deserted and valueless; the organization supporting this population will be disbanded and the area will revert largely to an unproductive wilderness yielding no taxes to the support of the county. The owners originally figured that they could not afford to undertake reforestation, that fires could not be kept out, that planting would be required, and that the cost of growing timber was about as follows:

Interest on land at $5.00 per acre, for 40 years at 6 per cent	$ 46.28
Cost of planting, at $10.00 per acre for 40 years at 6 per cent	102.86
Fire protection 15 cents per acre for 40 years	23.21
Taxes at an average of 25 cents per acre	37.67
Total "cost" of an acre of timber	$209.82
Probable yields, 12,000 board feet, "Cost" per thousand board feet	$ 17.48

They considered this cost excessive and did not undertake fire protection. In forty years this entire depletion of forty times $450,000 must be returned from income, plus the depreciation of the plant, and of the town. To continue in the business is found to be impossible since all available opportunities elsewhere are already developed as going concerns. The capital must therefore be put out at interest or invested in undertakings unfamiliar to the owners, with prospects of greatly decreased rate of earnings.

A second company similarly situated undertakes from the initial year to reëstablish the forest as a crop as soon as it is cut over. This is done by leaving a few seed trees on the area, whose rapid growth make them an interest-bearing investment and secures the reproduction of seedling pine without the expense of planting. This company considers the cost of protection, taxes on cutover lands and slash disposal as a current operating expense of a going concern, met from current income. The annual cost of fire protection, 15 cents per acre on 300,000 acres, is the

heaviest item, amounting to $45,000 per year. Taxes on cutover lands may be charged to the project although the company would be forced to retain these lands in a large measure for most of the period regardless of their final intentions. These average 25 cents on half the area for the period, or 12½ cents per acre throughout, the remaining taxes being chargeable to the land bearing mature timber. This gives an annual charge of $37,500. Slash disposal on the area cut annually or 7,500 acres costs $5.00 per acre or $37,500, giving a total annual charge of $120,000 to maintain 300,000 acres in productive condition, a cost per acre of 40 cents annually.*

The yield per acre at 40 years is 12,000 board feet,† sufficient to perpetually maintain a cut of 90,000,000 board feet per year. The net annual saving to this company is the difference between the depletion charge and the annual cost,

$$\$450{,}000 - 120{,}000 = \$330{,}000.$$

The value of the timber standing at the end of the period is approximately an average of 5,000 board feet per thousand board feet at $5.00, or $17,500,000 as against no value for the depleted tract. To this is added the value of the plant, the town and the business as a going concern. The net cash cost of growing the timber is 40 cents per acre annually or $16.00 per acre in 40 years for a crop of 12,000 board feet, or $1.25 per thousand board feet stumpage cost, as against the $17.48 of costs computed by the method of considering interest as a cost, and charging compound interest against the expenses of a going concern.

By such calculations as cited in the first example above, lumbermen have probably lost more potential profit than they have ever succeeded in making in their operations.

* These figures are purposely high.

† This is about one-half of the possible yield on well-stocked areas.

CHAPTER XVI

INCOME, INVESTMENTS AND COSTS IN STUMPAGE APPRAISALS

144. Importance of Use of Average Figures in Appraisal. — In this and the succeeding chapter will be set forth the methods of conducting an appraisal of stumpage value by an owner or prospective purchaser for the purpose of determining the probable marginal economic value of the stumpage as derived from the value of the products to be obtained, and thereby indicating as closely as possible the price that can be paid without incurring a probable loss in operation (1) (§ 139).

The discussion is modelled after the methods prescribed by the U. S. Forest Service for the sale of National Forest timber and contains all the elements necessary in appraisals based on the practice of forestry on the lands of the owner.

As indicated by the chart in § 139 there are six major factors influencing appraised values, and when all of these are considered, the resulting appraisal should be more than a mere individual judgment as to either true value (use value) or market value. The main advantage of an appraisal is that it applies to the specific tract to be valued, and can consider the probable cost and income from logging the timber growing on this tract, which cannot be exactly compared with any other (§138). Whether for buyer or seller, the most important source of reliable data for an appraisal is the calculation of stumpage value based on probable future income minus future costs and margin for profit and risk in logging and manufacture. A seller's appraisal on this basis should indicate the lowest price which can be accepted. If costs are exaggerated, the seller's price will be beyond the reach of the buyer. The buyer must not minimize costs or he in turn will be tempted to pay too much and lose his profit, while if he exaggerates these costs he may lose out in competitive bidding. Hence such appraisals are equally valuable to either party. Appraisals based on past cost of the timber plus carrying charges and interest are of no use whatever in determining stumpage values (2) (§ 139).

The outstanding feature of appraisal computations based on

use value or net income from sale of products is the effect upon stumpage values of every item both of income and of expense. Stumpage is a marginal or residual value by this method, obtained by the equation:

Stumpage value = Gross income — (Total costs + Profits)

An addition of 10 cents per thousand feet log scale to the price of lumber means that stumpage is appraised at 10 cents more. An increased cost of 10 cents per thousand feet in logging, due to any item whatever, means that stumpage is appraised at just 10 cents less. It is quite evident that such exactness is impossible of attainment in appraisals, and that with the utmost care, the opinion or calculation of two different appraisers using identical methods might differ by 25 cents to 50 cents per thousand board feet, if not checked by one or more of the other major factors entirely separate from this one method of appraisal. In actual practice, the difference between cost of two operators on identical chances may be as much as 15 to 20 per cent.

There is always a wide difference in efficiency between operators, and in no line of business is it possible to secure continuously a profit margin so wide that all who choose to undertake the business can succeed regardless of this element of efficiency. Inefficiency is indicated by excessive costs under identical conditions. In appraisals, therefore, average costs for identical processes common to a given region in which valid comparisons can be made must be taken as the basis for stumpage appraisals, with the knowledge that the more efficient operators will make larger than ordinary profits and the least efficient will be bankrupted as the price of his incompetency.

Costs of operations or processes cannot be obtained by analyzing or timing them unless finally checked by actual costs of the operation for the year which gives average speed of production and includes lost time, shut-downs, and other common factors of delay.

It is usually possible to obtain average selling prices since these are quoted as market prices, and may be averaged for the period thought to be adequate to obtain a fair basis for the sale in question.

145. Gross Income. — *Elements to be considered in appraisals.* An appraisal based on this method considers four main

elements, namely, total income from sales, depreciation of fixed investments, total operating costs and margin for profit and risk. Then stumpage value = gross income — depreciation — operating costs — margin for profit and risk.

For products other than lumber, such as cross ties, poles or posts, the price received by the operator at the point of delivery determines the income. For saw logs, the price of lumber f. o. b. cars at the mill gives the most uniform basis of income. Prices for logs when sold as such are not accepted as the basis of appraisals by the U. S. Forest Service, the lumber market being taken in all cases to determine the margin for stumpage. Log prices serve as a check on the appraisal but cannot be substituted for lumber prices as a standard method because there are only a few real log markets in the United States, and the cost of log transportation limits any seller in the marketing of his products in this form, giving mill men a large relative monopoly strength (3) (§§ 139 and 28). The prices of different grades of lumber of the separate species are determined for a given region forming an economic unit and affected by the same freight rates to competitive markets, and are then reduced to prices f. o. b. the mill by deducting local freight charges if any.

The method of computing the average mill run price may be shown by the following example for White Pine in Idaho.*

Grades	Per cent of total	Selling Value	Weighted Value
B Select	5	$45	$2.25
C Select	4	38	1.52
D Select	6	27	1.62
Shop	3	20	.60
No. 1 Common	30	25	7.50
No. 2 Common	24	21	5.04
No. 3 Common	15	15	2.25
No. 4 Common	8	11	.88
No. 5 Common	5	6	.30
Total	100	...	$21.96
Depreciation in yards	5	...	1.10
			$20.86

* Instructions for Appraising Stumpage on National Forests, U. S. Dept. of Agriculture, p. 58.

The percentage of mill cut which will fall into each standard grade must be determined by direct examination of the timber, classification of the logs which will be cut into log grades or of the total stand into per cents of grades and derivation of the average weighted price from these per cents. Mill scale studies are required or their results must be available.* Allowance for deterioration in grade in the yard and during seasoning and handling must be made.

If necessary to obtain the average lumber selling price of all of the stumpage in mixed stands, a similar calculation may be made by species, as follows:

Per Cent	Species	Average selling price of species	Weight in average price for the chance
30	Western white pine	$21.00	$6.30
5	Yellow pine	17.00	.85
12	Larch	13.00	1.56
18	Douglas fir	13.00	2.34
3	Englemann spruce	15.00	.45
25	White fir	12.50	3.125
7	Western red cedar	12.00	.84
100	Average for the chance ..	.....	$15.465

Planed and finished lumber, in the proportion in which it is produced, is taken as the basis of prices, but manufacturing units such as box or sash and door factories are excluded, the lumber being charged to them at current prices. By-products such as lath and slabwood must be included either by combining the cost and income with the mill operation or by adding the profit per thousand feet of mill output to income.

146. Elements of Cost. — *Fixed investment,* as applied to lumbering operations, is the money expended in constructing or acquiring the operating plant. It comprises not merely buildings, railroads, and woods improvements, but machinery and equipment, such as cars and locomotives, donkey engines and teams. It includes the replacement of worn-out structures or equipment which must be renewed during an operation. Fixed investment as distinct from working capital is the outlay for land, structures and equipment, which can be recovered only in a considerable

* Chapman's Forest Mensuration, Appendix A, Page 461.

period of time as portions of the cost of the plant are returned from the business and charged off in its accounts.

An *initial fixed investment* is the expenditure for these purposes required at the beginning of an operation, to start production at the normal capacity of the plant. A *subsequent fixed investment* is any later outlay for the extension or renewal of improvements or equipment.

Depreciation. Shrinkage in the value of fixed investment is called depreciation. At the end of an operation the buildings, transportation improvements and equipment are valueless or worth but a portion of their first cost. Depreciation is this decrease in the value of fixed investments which must, in one form or another, be restored to the original capital from the proceeds of the business.

Residual and wrecking values. Fixed investments usually have some value at the end of an operation. If this value exists because of opportunity for continued use in place, as where additional blocks of timber are available to a partly used mill, it is known as *residual value.* If the value is only for removal and use elsewhere, or for sale as scrap, it is known as *wrecking value.*

Residual or wrecking value is equivalent to first cost less depreciation. If the amount of depreciation is small, residual value approaches the original investment and may nearly equal it in the case of railroads and other permanent structures. Investments in the lumber business, however, are seldom maintained at a constant capital value as is frequently the case in industries of a more permanent character.

Operating costs consist of all expenditures in an operation except for stumpage and fixed investments. They are the current charges for labor, supplies, and other expenditures required in logging and manufacturing, from stump to car. They include maintenance, taxes, insurance, and general expense.

Maintenance includes all charges for keeping buildings, structures, machinery and tools in condition for doing the work for which they were designed. It is a current operating cost consisting of labor, materials and new parts of equipment used in repairs. Unlike depreciation, maintenance bears no direct relation to the cost of fixed investments.

No arbitrary line need be drawn between maintenance and fixed investments in the matter of replacements. The replacement of

complete units like boilers, burners, dry kilns, engines, band mills, planing machines, locomotives, or donkey engines should be regarded as a subsequent fixed investment. The replacement of small parts of mill machinery such as band saws, belts, pulleys, etc., should be regarded as maintenance. The replacement of short-lived equipment, such as steel cables, saws, wedges and axes are ordinarily carried as a current operating cost, but may be treated as an investment. Sound local trade practice should guide the treatment of these items in appraisals.

General expenses is a convenient term to designate the operating costs which are not directly chargeable to any distinct and recognized step in logging or manufacture. It includes supervision of the operation as a whole, office expenses, etc. It can exclude taxes and insurance, which are sufficiently specific to be treated separately.

The term *overhead charges* is frequently used in the trade to designate expenditures of this character. General expense is preferred as a more applicable term.

Interest must not appear as a cost, nor is it quoted as measuring income. The margin for profit and risk may be expressed as a rate to be allowed as income on investment. *Interest is allowed as an addition to the fixed investment,* on money invested in improvements *previous to the date on which logging begins.* Simple and not compound interest is used for the year or years covered by the investment.

Profit is the money returned from sales of the product over and above depreciation of fixed investments, operating costs, and payments for stumpage. Profit must be distinguished from a *margin for profit and risk.* The latter is the profit element which should be used in appraisals. Aside from the actual profit estimated as due the operator, it includes a surplus to cover unforeseen losses and risks. The margin for profit and risk may be calculated as a percentage return on the money invested, a given amount per unit manufactured, or a percentage of the total unit cost of production.

147. Analysis of a Proposed Operation. — *Boundaries and cut of the sale area or "chance."* The discussion of principles and methods will be facilitated by a bird's-eye view of the appraiser's work. After the estimate and topographic map are completed, the first steps are to determine the boundaries of the sale area, eliminating unmerchantable timber and ground on

which logging is impracticable; the proportion of each species which can be cut as demonstrated by sample marking on the area or under approved methods of marking for the forest type; and the estimated cut by species, log grades (if customary), and lumber grades if the quality of the timber makes them important.

In defining the boundaries of the cutting, it is necessary to approximate the amount of additional stumpage which will logically be handled by the same improvements; and also other stumpage which is under the control of a prospective purchaser or may be obtained by him and which forms part of the same chance. These factors directly affect the layout and depreciation of fixed investments and may bear upon the timeliness and desirability of the sale.

Most important factors. The factors whose careful working out is then most essential to an accurate appraisal are:

(1) The quality of the timber and value of its products.

(2) The investment required, involving a grasp of current lumbering methods and equipment and of the topographic layout and plan of operation.

(3) Operating costs.

In some regions the grade of the product is the single factor of greatest importance in appraisals for large sales; but in other regions, where there is no great variation in the quality of the timber, logging investments and costs are the most important factors affecting stumpage values.

Layout of the operation. It is first necessary to decide upon the general methods of logging which should be employed, the size and type of manufacturing plant if one is required, and the size, annual output and duration of the operation. The location of the main artery of log transportation, whether by railroad, drivable stream, sleigh road, or flume, then follows; and the projection of its principal feeders, such as logging spurs, chutes, pole and other roads, forming the complete system of log transportation. Judging the quality of stumpage and a clear grasp of the layout of logging improvements are the most important requisites of accurate valuation.

From the approximate location of landings or banking grounds on the main line of transportation or its feeders, the appraiser should block out the area into logging units for which costs from stump to landing need to be computed separately on account of variations in the character of the ground or timber.

Investments in logging improvements. The appraiser is now ready to estimate the cost of transportation improvements from landing to mill and of logging improvements from stump to landing. Working these fixed investments out, unit by unit, he should estimate the initial outlay required to put the operation under way; then, the additional sums which must be expended from time to time as logging is extended into additional blocks. He should determine approximately how long each improvement, whether a spur grade, sleigh road, or splash dam, will be in use. On a railroad chance, for example, a certain mileage of steel rails, picked up and relaid on spur after spur, may meet the requirements of log transportation for a considerable period, requiring additions only as the actual mileage in use at the same time must be increased to reach the less accessible timber. This represents a stable investment continued with little change throughout the operation. On the other hand, the cost of grading a spur and laying track for logging out a single gulch may be invested for but two or three years, after which the spur is abandoned. There may thus be frequent expansions or contractions of the investment in woods improvements.

Residual or wrecking values. The next requirement for the appraisal is the residual or wrecking value of each improvement at the end of its use in the sale; hence the annual rate at which the original investment must be depreciated. This leads easily to the investment on which profit is due and to the average yearly depreciation.

Investments in equipment. The determination of fixed investments, residual or wrecking values and yearly depreciation must be repeated for transportation and logging equipment such as rolling stock, donkey engines, teams and trucks. The first cost of the various items of machinery and apparatus must be ascertained, the rate at which they are worn out, and the time when each kind of equipment must be increased or can be reduced as the operation is extended over the entire chance.

Investment in manufacturing plant. A like computation must be made in land, buildings and equipment for the manufacturing plant where one is required. This is often the most permanent part of the enterprise. Its depreciation requires an approximation of the additional timber, regardless of ownership, which is accessible and should contribute to its operating life.

Determination of operating costs. The next study of the appraiser is to estimate the cost of maintaining the various parts of the plant in working condition. This is a current operating cost, but from its nature must be considered in connection with the character and durability of each structure or class of equipment. The calculation is then ready for the remaining operating costs, chiefly labor, for logging, transportation and manufacture. These must include any special or additional costs arising from contract requirements of forestry such as brush disposal or cutting snags. The calculation should be carried through all details of the business, however remote from the woods. General expenses for superintendence, lumber sales, clerical and other office charges, taxes on improvements and equipment, on logs in transit and on lumber in the yard, fire insurance on the portions of the plant and stock of lumber and logs which are normally insured by conservative operators and liability insurance for injuries to labor are all items which must be estimated in operations to which they apply.

Determination of working capital. With the operating costs before him, the appraiser is in a position to approximate the working capital, as distinct from fixed investment, which is required to carry the business with its current charges and its periodic returns from sales of lumber. This involves particularly an estimate of the yard stock which must be carried on hand in the normal course of business, or the average length of time during which the costs put into lumber must be carried by the operator before he is reimbursed by its sale.

Lumber selling prices and overrun. Finally the mill-run selling price of each species to be cut must be ascertained, together with the value of lath, slabs, and any other by-products whose manufacture may be practicable. Mill overrun for the class of timber must be also determined and, in sales of saw timber, costs throughout the whole operation and all returns put in terms of log scale.

When these estimates are reduced to final terms, the appraiser will have before him:

(1) The amount of money required for the business, in fixed improvements and equipment and in working funds.

(2) The part of this capital which must be depreciated; that is, which is not returned in tangible assets of some form at the conclusion of the sale.

(3) The operating costs, in terms of thousand board feet, log scale, from the stump to the sale of lumber, or in terms of the appropriate unit of measure if the product is not lumber.

(4) The value of the lumber and by-products manufactured from the average thousand board feet, log scale, of each species, or the corresponding unit of value if the product is not lumber.

148. Fixed Investments. — The following classification of fixed investments had been adopted by the U. S. Forest Service and may be modified to suit local conditions.

I. *Investment—Logging*:

(1) Logging Improvements—Stump to landing—First cost of—

a. Chutes.
b. Roads.
c. Slides.
d. Landing improvements, or
e. Other structures used in skidding, hauling, or landing.

(2) Logging equipment—Stump to landing—First cost of—

a. Teams.
b. Sleds.
c. Big wheels.
d. Bummer or go-devils.
e. Donkey engines or steam skidders.
f. Trucks, caterpillars, etc.
g. Steam or horse loaders.
h. Woods tools, and
i. Any other logging equipment or appliances.

(3) Transportation improvements—Landing to mill or mill to railroad shipping point—First cost of—

a. Railroads, including—
(*a*) Spurs and sidings.
(*b*) Roundhouses, coal burners, tanks, and other permanent structures.
b. Flumes.
c. Stream improvements.
d. Roads, or
e. Other transportation improvements.

(4) Transportation equipment—Landing to mill, or mill to shipping point—First cost of—

a. Railroad rolling stock, track tools, etc.

b. Marine equipment, tugs, bateaux, etc., and driving tools.

c. Teams, trucks and harness, sleighs, traction engines, gasoline trucks or other equipment including hand tools, used in transporting timber from landing to mill, or mill to shipping point

(5) Woods camps and other buildings, together with water system.

(6) Camp equipment—

a. Kitchen and mess equipment.

b. Bedding, heating equipment, and camp fittings.

(7) Repair equipment—Carpenter, blacksmiths, and machine shops, etc.

II. *Investment—Manufacturing*:

a. Site.

b. Pond and dam; other site improvements.

c. Sawmill.

(*a*) Building.

(*b*) Equipment.

(*c*) Power.

(*d*) Lath mill, etc.

d. Finishing plant.

(*a*) Building.

(*b*) Equipment.

(*c*) Power.

e. Dry kiln.

f. Waste burner.

g. Sheds, docks, platforms, pile bottoms.

h. Office and miscellaneous buildings.

i. Yard equipment.

j. Light, fire protection, etc.

The purpose of appraising the value of these fixed investments is as a step in determining the average interest-bearing invest-

ment covering the period of the operation on which the margin for profit and risk can be based.

The guiding principle in determining the character and value of the fixed investment required for a given operation is maximum net earning power while accomplishing the objective which is the logging and manufacture of a given quantity of timber. The limiting factors are the total supply of timber available, the capacity of the market to absorb the output, and the number of years over which the operation should be extended. These factors indicate the annual rate of production on which the capacity of the mill must be based. Provision for a capacity greater than justified by the timber supply, or exceeding demand, means too large a fixed investment. Too small a mill restricts the output, permits waste of timber and does not earn sufficient profit on investment in land and timber. The second factor in determining size of mill is efficiency in operation. Where the quantity of the timber is not the limiting factor, the experience and customs of the region will indicate the normal capacity of the mill. Small mills may be necessary where timber is scattered, but are inefficient where it is abundant, by comparison with a larger type. Beyond a certain point, increase in size tends to decrease efficiency.

Perhaps the most important single consideration in determining the size of the mill is that of depreciation. The fixed investment in the sawmill plant, less the small wrecking values, must come back from the timber which this mill will cut and is spread over the total cost, as a charge per thousand board feet. If the annual rate of cutting is gauged so that the timber cut will last as long as the normal life of the mill, this investment is kept to the minimum and the depreciation charge is at the lowest possible figure. Doubling the capacity of the mill and its cost doubles this depreciation charge per unit of product, since the total output remains the same, only the rate being increased, with a corresponding curtailment of the period of operation. This speeding up is sometimes done deliberately in order to increase the rate of liquidation of assets frozen in timber, and the increased cost of depreciation offset against the advantage sought.

Private operators usually acquire sufficient timber to guarantee a reasonable depreciation where the investment is large, before constructing the plant. Where public timber is sold, the mill man must compete for additional tributary timber under sealed bids.

Under National Forest policy this timber will not be sold until he is ready to buy, and the fact that his plant has already earned part of its depreciation enables him to bid a normal price where a competitor, forced to erect a new plant for less timber, could not meet this price. This ability to spread and thus reduce depreciation gives to the established mill a legitimate advantage over any new competitor for public timber, and justifies the seller in basing the allowance for depreciation on the total quantity of timber tributary to the mill rather than either that publicly owned or merely the amount offered in a single sale.

Where companies operate commissaries, at camps or in a closed town, a large part of the profits may be derived through prices adjusted to the wages paid. Where these operations are independently handled it is not possible to include these profits as income with lumber sales, hence fixed investment will exclude commissaries and boarding houses, except when handled as an integral part of the operation. Investments in re-manufacturing plants are likewise excluded.

The fixed investment in logging including transportation of logs must be sufficient to provide a continuous and dependable supply of logs to the mill. Here the same general rule holds good. Every outlay whatever its character must be gauged by the rule of efficiency or securing the maximum net income from this specific outlay, being just as careful to avoid spending too much on any item as to spend too little. For instance, in constructing temporary railroad grades and spurs, each portion of the system must be paid for entirely out of the timber which goes out over it, hence the amount expended on each spur is the minimum which will bring the sum of costs for both construction and transport to the lowest total. This rule applies as well to main line grades, but owing to the enormously greater traffic over them, a small saving in haul on each thousand feet gives a total saved by better construction large enough to justify outlay on grade reductions and roadbed, which on spurs would be a total loss. It is the ability to decide just how much to spend on each individual portion of the investment that differentiates the efficient operator from the inexperienced one as certainly as the ability to make this investment function to full capacity when installed.

149. Depreciation of Fixed Investments. — It was necessary

in § 148 to discuss depreciation of the investment in the sawmill plant as related to the determination of the size of this plant. In this paragraph the treatment of depreciation as a cost will be undertaken.

In the investment of capital in an enterprise, the purchase of capital assets in the form of land and other durable forms, and the expenditure for improvements and equipment does not in itself constitute a true cost but a mere exchange of capital (§ 24). The proposed use of this property is what gave it its purchase value, and this value will disappear when the property ceases to be useful, from whatever cause. These causes are physical by wearing out through use, and economic by disappearance of utility independent of wear. Where an investment is made for the purpose of logging and manufacturing a given quantity of timber, all utility terminates with the exhaustion of this timber, except for those parts of the investment which can be used in place for an entirely different purpose or can be transported to another place for further use.

Movable equipment usually depreciates to zero through actual use, or else has a wrecking value for use elsewhere. Investments in logging camps and railroad grades, on the other hand, have practically no wrecking value and are depreciable to zero regardless of their condition at the end, since their economic utility is gone. Land such as mill sites usually shows no depreciation in value. Railroads which can be converted into common carriers are not subject to depreciation.

This depreciation or shrinkage in value of physical assets representing the cash investment or capital is therefore a true cost comparable with operating costs except that the loss or cost is distributed or prorated over the period of use instead of entered as of the date of original expenditure. Only by an accurate appraisal of the amount of this cost, and the consequent equivalent amount of gross income required to replace it, can the required margin for profit and risk, and final residual value for stumpage, be found.

It is thus necessary to set aside from income an amount equal to depreciation before the true net income for the year, available for dividends, can be determined. This depreciation may or may not be earned in that year any more than the other expenses. It is shown on the balance sheet as a loss of value of physical assets

and a corresponding reduction of the surplus, which is compensated by additions to cash on hand from the earnings, appearing in the surplus.

E. g. for an investment of $10,000 with net earnings of $2,000 and a depreciation of $1,000 annually, the balance sheet shows:

	Assets		Ownership	
	Physical	Cash	Capital	Surplus
First year	$10,000		$10,000	
Second year	9,000	$2,000	10,000	$1,000
Third year	8,000	4,000	10,000	2,000
Fourth year	7,000	6,000	10,000	3,000
Fifth year	6,000	8,000	10,000	4,000

Since only the surplus is available for dividends, the above management would accumulate a large cash reserve, which at the end must equal the initial investment. This idle money is capable of earning interest. Hence one of two methods is pursued. Either a smaller sum set aside annually is actually invested, so that the total of these withdrawals from earnings plus compound interest will equal the total depreciation at the end of the operation, a method used in the payment of public bonds, or else the idle money is actually returned to the owners and thus reduces the size of the investment annually by the amount of the depreciation. In this case the investment would be:

Second year	$9,000
Third year	8,000
Fourth year	7,000
Fifth year	6,000

and would coincide with the depreciated value of the assets. Let

Z = Annual sum for depreciation
D = Total depreciation
V = Residual or wrecking value
I = Initial investment

Then $D = I - V$ in all cases.

By the first method of a so-called sinking fund, p being the rate of interest obtainable on money;

$$\frac{Z}{.0p}(1.0p^n - 1) = D$$

and

$$Z = \frac{D(0.0p)}{1.0p^n - 1}$$

By the second method, or so-called straight line depreciation, by which equal sums are set aside or withdrawn annually,

$$Z = \frac{D}{N}$$

The U. S. Forest Service uses this method in all appraisals.

Other methods may be used, by which the rate of depreciation is made heavy at first and tapered off, or the reverse, and some companies determine the amount to write off annually on the basis of the earnings for the year. In stumpage appraisals a uniform system is needed, and straight line depreciation will give this and also permit the determination of the average interest-bearing investment which is the basis for determining the margin for profit and risk (§ 154) by the method most used in large operations (§ 159).

Depreciation and the amount of the fixed investment for the year are therefore interdependent. In calculating the required investment in advance, for the appraisal, capital should not be considered invested until it is actually paid out or in use, and should be considered as withdrawn by depreciation at the rate at which this depreciation is reckoned by the method adopted. Following this rule, fixed investment would decrease steadily by depreciation, but would be increased from time to time by the addition of subsequent investment in equipment, transportation or other items.

Since the purpose of the appraisal is to indicate a stumpage price and this cannot be done until the margin for profit and risk is first determined, the most important element of which may be the rate of earnings to be allowed on the capital investment, it is necessary as a first step to average the investment for the entire period covered by the enterprise. For the mill, this means its probable life and average value. This sum when found is made to apply uniformly to any portion of this total period. For the logging, it applies solely to the period of the sale except where major units of transportation useful in other sales are involved, when for these units the above rule applies and the average investment only will be applied to the specific appraisal.

Table III indicates the method of arriving at the basis of physical depreciation; which will be derived in all cases from experience in operation:

TABLE III

The Basis for Physical Depreciation

Item	Reasonable physical life	Reasonable wrecking value
Auto trucks	3 to 4 years	10 to 20 per cent.
Box and door factories	15 to 20 years	Do.
Blacksmith outfit	4 to 5 years	Negligible
Big wheels	3 to 5 years	Do.
Cables, steel, main lines	½ to 1 year	Do.
Cables, steel, back or supported lines	1 to 2 years	Do.
Camp equipment, bedding staves, etc.	3 to 5 years	Do.
Camps, permanent	Period to be in use	Do.
Camps, portable	7 to 10 years	Do.
Camps, car	10 to 12 years	10 to 20 per cent.
Cookhouse equipment	3 to 5 years	Negligible
Chutes	Period to be in use	Do.
Dutch ovens	....do	Do.
Dams	....do	Do.
Dry kilns	15 to 20 years	Do.
Fire-protective system	....do	Do.
Flumes	Period to be in use	Negligible
Furniture and fixtures	10 years	Do.
Gasoline saws, etc.	4 to 5 years	Do.
Hammers, cant hooks, etc.	1 to 2 years	Do.
Horses and harness	4 to 6 years	10 to 20 per cent.
Locomotive cranes and steam shovels	10 to 15 years	Do.
Locomotives, rod	15 to 20 years	Do.
Locomotives, geared	10 to 15 years	Do.
Log cars, light	8 to 10 years	Negligible
Log cars, heavy, standard	10 to 12 years	10 to 15 per cent.
Lumber sheds and warehouses	15 to 20 years	Negligible
Machine Shop	....do	10 to 20 per cent.
Plank roads	Period to be in use	Negligible
Planing mills	15 to 20 years	10 to 20 per cent.
Pond improvements	....do	Negligible
Power plant (not hydroelectric)	....do	Do.
Railroad steel, 56 pounds or heavier	....do	20 per cent.
Railroad steel, light	12 to 15 years	15 to 20 per cent.
Railroad buildings	Period to be in use	Negligible
Rail yard systems	15 to 20 years	5 to 10 per cent.
Railroad grades	Period to be in use	Negligible
Refuse burners	10 to 15 years	Do.
Sawmills, permanent	15 to 20 years	10 to 20 per cent.
Sawmills, small portable	8 to 12 years	Do.
Saws, axes, wedges, etc.	3 to 6 months	Negligible.
Steam loaders	10 to 12 years	10 to 15 per cent.
Steam skidders	8 to 10 years	Do.
Stream improvements	Periods to be in use	Negligible.
Telephone and lighting systems	15 to 20 years	Do.
Tote or freight roads	Period to be in use	Do.
Tractors	4 to 5 years	10 per cent.
Wagons, trucks, etc.	3 to 5 years	Negligible.
Water and sewer system	15 to 20 years	Do.
Yard improvements and equipment	7 to 10 years	Do.

Where logging involves expensive railroad construction, the possibility that such railroads may develop as permanent common carriers might make the difference between an actual and a negative stumpage value, since such a possibility means the elimination of this depreciation charge, substitution of freight charges on timber as an operating cost and separation of the investment in the railroad from that in the enterprise being appraised. In the absence of outside permanent sources of traffic such roads must be included in the investment and depreciated from the standing timber as usual.

150. Calculation of Annual Depreciation and Average Profit-bearing Investment. — The two elements required in the appraisal as touching fixed investments are thus seen to be the average profit-bearing investment for the period and the total depreciation. Depreciation must ultimately be expressed in common with operating costs as a charge per unit of product, and this can be done by dividing the total depreciation by the total cut, or the annual depreciation by the annual cut, the result being identical. The item of annual depreciation is needed, however, in determining the average profit-bearing investment and for this reason will be calculated. For itself, it is not necessary. The sum of all depreciation items, divided by the total estimate, would give the result.

In determining the average profit-bearing investment resulting from annual fluctuations, the following two methods are possible:*

By separate years. The most exact method is to carry for each year of the operation (1) the investment required at the beginning of the year, (2) its depreciation during the year, and (3) additional investments necessary at the end of the year. The estimated depreciation during each year is deducted from the investment at its beginning. This figure, with the addition of any new outlays required during or at the end of the year, is the investment in the business at the beginning of the following year. Thus is obtained the profit-bearing capital at the beginning of each year, with the average for the entire operation; the depreciation during each year and for the whole period; and the wrecking or residual value at its end.

By investment items. A simpler and quicker method is to

* From "Instructions for Appraising Stumpage on National Forests," U. S. Dept. of Agriculture.

calculate for each improvement or purchase of equipment the yearly depreciation and the average profit-bearing investment, both prorated over the entire operation. Yearly depreciation is determined by dividing the total shrinkage in the value of the improvement or equipment by the number of years in the operation. The average profit-bearing investment is determined by the following formula:

One-half of the sum of the initial investment and its residual or wrecking value multiplied by a fraction whose numerator is the number of years during which the particular improvement or equipment is in use and whose denominator is the total number of years in the operation, plus one-half of the yearly depreciation.

This formula may be expressed as follows:

Let I represent initial cost;
r the residual value;
n the number of years in use;
y the number of years planned for the operation; and
d the average annual depreciation.

Then

$$\frac{I+r}{2} \times \frac{n}{y} + \frac{d}{2}$$

equals average fixed investment.

Wherever depreciation takes place in a straight line—that is, at a uniform rate annually during the period of use—this method yields the same results as a calculation by separate years. If depreciation does not progress at a uniform rate throughout the period of use, it yields a different and usually a lower average investment.

The addition of one-half of the annual depreciation in obtaining the average profit-bearing capital under each item of investment is based on the assumption that depreciation is charged off at the end of each year rather than currently during the year. This is equivalent to calculating the average investments as at the beginning of each of the respective years in the operation rather than at the middle of the year. To illustrate:

A $10,000 investment is to be wholly depreciated in 10 years; at $1,000 annually. The successive investments at the beginning and middle of each year are:

	Beginning	Middle
First year	$10,000	$9,500
Second year	9,000	8,500
Third year	8,000	7,500
Tenth year	1,000	500
Total	$55,000	$50,000
Average	5,500	5,000

An average for the beginning of each year is obtained under the formula by taking one-half the sum of the initial investment and residual value ($10,000 + 0), together with one-half of the annual depreciation, $1,000. The addition of one-half of the annual depreciation thus results in a figure representing the investment during a 12-month interval in the exact center of the operaing period, or the true mathematical average.

The calculation of average depreciation and profit-bearing capital by each investment item will be of more general service because of its shorter and simpler form than the other method of calculation, by separate years. An illustration follows:

In a 10-year operation, an investment of $10,500 in logging equipment is required for the first year's operation. At the end of the first year, $1,200 worth of additional equipment must be purchased; and at the end of the fifth year, $1,800 worth must be procured. This completes the logging equipment required for the entire 10 years. All of the machinery is depreciated at the rate of 10 per cent annually while in actual use. The calculation of the average profit-bearing investment in this equipment is as follows:

Investment and depreciation—Logging equipment.

Years of use	Initial investment	Yearly depreciation	Wrecking Value	Average profit-bearing investment
10	$10,500	$1,050	.....	$5,775
9	1,200	108	$120	648
5	1,800	90	900	720
Total ...	$13,500	$1,248	$1,020	$7,143

The annual depreciation of the first item is one-tenth of the initial investment; of the second, one-tenth of a total shrinkage of $1,080; of the third, one tenth of a total shrinkage of $900.

The average interest-bearing investment under the first item is—

$$\frac{10}{10} \times \frac{10500}{2} + \frac{1050}{2}$$

under the second—

$$\frac{9}{10} \times \frac{1200 + 120}{2} + \frac{108}{2}$$

under the third—

$$\frac{5}{10} \times \frac{1800 + 900}{2} + \frac{90}{2}$$

The estimated cost of roadbed, ties, and laying steel for the first year's logging is $4,500. This portion of the railroad will be in use throughout the entire operation. Subsequent investments must be made in roadbed, ties, and labor for laying rails. There will be no residual or wrecking value for these investments. The calculation of the average investment, with the estimated period of use of each item, is as follows:

Years of use	Initial investment	Yearly depreciation	Average profit-bearing investment
10	$4,500	$450	$2,475
2	1,800	180	270
1	1,100	110	110
2	1,600	160	240
1	2,100	210	210
5	1,500	150	450
2	2,200	220	330
1	1,700	170	170
2	2,500	250	375
Total	$19,000	$1,900	$4,630

The average interest-bearing investment is computed for each item, as 10/10, 2/10, 1/10, etc., of one-half of the initial outlay, this being a 10-year operation, plus one-half of the yearly depreciation.

151. **Operating Costs.**—*Standard Classification.* The following classification of operating costs will be used as standard by the U. S. Forest Service and will serve as a guide in any appraisal.

Classification of operating costs.

1. Logging.
   - (1) Stump to landing.
     - *a.* Felling.
     - *b.* Bucking.
     - *c.* Swamping.
     - *d.* Trimming, peeling, and sniping (included in swamping or yarding as case may be).
     - *e.* Skidding or yarding.
     - *f.* Hauling, chuting, roading, etc.
     - *g.* Decking or piling at yards.
     - *h.* Maintenance—supplies and repairs.
     - *i.* Supervision.*
   - (2) Landing to mill.
     - *a.* Loading, breaking out landings, or other work at landing itself.
     - *b.* Scaling.
     - *c.* Railroading, hauling, driving, fluming, or other transportation charges.
     - *d.* Unloading at mill pond or yard.
     - *e.* Maintenance—supplies and repairs.
     - *f.* Supervision.*
   - (3) Extra costs of logging under Forest Service regulations.
     - *a.* Cutting of timber under protection requirements.
       - (*a*) Cost of cutting diseased or weed trees.
       - (*b*) Cost of cutting snags.
     - *b.* Slash disposal.
       - (*a*) Brush piling, or lopping and scattering.
       - (*b*) Burning piled or loose slash.
       - (*c*) Clearing firebreaks.
       - (*d*) Burning slash as cut.
2. Manufacture, mill pond to f. o. b. cars.
   - (1) Sawmill.
     - *a.* Pond, handling logs in pond and putting on jack chain (labor).
     - *b.* Sawing, from log on jack chain until lumber leaves trimmers (labor).

* Use one supervision item for logging all woods work if preferred.

c. Sorting, carrying lumber to transfer chains, buggies or rolls, including grading and tallying (labor).
d. Power (labor).
e. Maintenance.
Supplies.
Repairs (labor and materials).
f. Millwright (labor).
g. Filing (labor).
h. Oiling (labor).

(2) Yard.
a. Transportation to yard, taking lumber from transfer chains, buggies, or rolls, or on delivery from kiln or planer, to piles.
b. Handling, piling, etc., exclusive of loading (labor).
c. Maintenance.
Supplies.
Repairs (labor and materials).

(3) Kiln.
a. Transportation to kiln.
b. Handling (labor).
c. Power (labor).
d. Maintenance.
Supplies.
Repairs (labor and materials).

(4) Planing mill.
a. Transportation to planing mill.
b. Handling (labor).
c. Power (labor).
d. Maintenance.
Supplies.
Repairs (labor and materials).

(5) Sheds.*
a. Transportation to sheds.
b. Handling (labor).

* Include under "Yard" if desirable.

(6) Loading.

a. Transportation to cars, including taking down yard piles, repiling in cars, etc.

b. Handling (labor).

3. Sales.

(1) Traveling salesmen.

(2) Commissions.

(3) Advertisements.

(4) Retail yards.*

4. Taxes and insurance.

(1) Taxes.

a. On permanent improvements, including franchise taxes.

b. On movable equipment.

c. On logs.

d. On lumber (yard stock).

(2) Insurance.

a. On logs.

b. On lumber.

c. On permanent improvements.

d. On equipment.

e. Liability insurance for injuries to workmen.

5. General expense.

(1) Cruising and layout of operation, surveys, etc.

(2) Protection of sale area from fire.

(3) Office expenses.

a. Timekeeping.

b. Clerical help.

c. Stationery, postage, telegrams, etc.

d. Rentals, lighting, water rents, telephone service, etc.

e. Association dues, etc.

* The operation should be carried through to retail yards only when the organization of a specific plant makes this necessary to a proper analysis of costs and returns. As far as practicable, returns will be based upon wholesale prices f. o. b. cars at nearest common carrier shipping point.

(4) Fees and other expenses in employing labor.

(5) Supervision: Salaries and expenses of administrative force, including foreman whose time is not wholly chargeable to specific operations.

Operating costs are averaged for a period of from three to five years. The unit or process cost figures should be checked by comparing the total of these costs with actual total operating costs on similar operations for an equal period. Unit milling costs are usually kept by operators on a lumber tally basis, and should always be reduced to terms of log scale by multiplying by 1 plus the per cent of overrun. Logging costs can usually be determined directly in terms of log scale. Doubt may arise as to whether certain items should be classed as operating costs or as fixed investment subject to depreciation. One suggested practice is to include in operating costs all investment or outlay which must be depreciated within one year. If the object serves for more than one year, depreciation is charged and spread over the longer period instead of charging the entire sum as a cost when first expended. Custom determines practice in this aspect. Railroad spur grades are usually charged to operating expense regardless of length of service while a main line would be depreciated. Equipment such as small tools, although rapidly used up, may be included by custom in the fixed investment. If the general rule above noted is in the main adhered to, minor variations will make but little difference.

Maintenance as an operating cost should include those expenditures which go for upkeep of existing equipment. By prolonging the life of this equipment, this charge tends to keep depreciation down to a normal figure.

Selling costs must be included, based on an average for the region and character of operation. For some conditions this is quite an item, while in other cases, as in sale of cross ties or poles, it may be negligible. Taxes and insurance form an important item of general expense not difficult to standardize. Income taxes are not considered an operating cost but serve to reduce profit, hence effect the margin allowed for profit and risk. Liability insurance or accident compensation to cover injuries to workmen is an important item. The cost of financing the investment or of obtaining money is also considered in this margin only, since interest on borrowed money is not allowed as an operating cost.

General expense includes supervision such as superintendents and office expense, which cannot be charged to specific operations.

152. Working Capital. — The theory of working capital is set forth in § 16. In a logging and manufacturing business it represents at any time the actual outlay or cost of every item of product still in the company's possession from the yard stock through the mill and into the woods, whether finished or unfinished. The sale of lumber replaces the working capital which was tied up in the stock which is sold, but not that invested in stock remaining in the yards. Income sufficient to replace in the treasury an amount equal to the working capital still leaves this capital invested, since it is evident that the sale of the yard stock would still produce this sum plus profit. Cost, not value of stock, measures the working capital invested.

When the concern begins to sell products, the working capital ceases to increase, not for the reason that operating costs are met from income, but because the capital tied up in the product is returned and released as fast as new capital is reinvested. Income is not coincident with cost but normally follows and results from it (§ 15). The fact that income is used to meet costs is a normal condition of a going concern which neither increases nor diminishes the working capital required. What does determine this is the size of the business or amount of expense incurred daily, and the length of the period which must elapse before the income is received which results from this outlay. Working capital is measured in any case by the same factors, namely, total cost to date of all material in process of manufacture plus total cost of all finished products not sold plus bills receivable for products not paid for.

A standard method of measuring working capital is to determine the cost of the average yard stock of finished lumber, to which is added the average bills receivable, plus the cost of the average stock of logs in the woods and pond, and the average credit for stumpage payments.

This same result may be arrived at by separating the yard stock from the logs and determining, first, the total annual cost of logging and of milling, and second, the average period during which these respective costs are tied up before release by the sale of the products. This period, divided into the year, gives the number of times the same capital can be re-expended in one year,

hence determines the total working capital required. E. g. it takes an average of one month for logs to reach the mill and another two months before the lumber is sold. The logging investment alone, per thousand feet, is turned over in three months, or four times per year, thus requiring one fourth of the total annual logging cost as working capital. The additional portion of total cost of one thousand board feet represented by milling and yard costs lies invested for two months, is thus turned over or released six times a year, and the working capital required for this portion of the operation is one sixth of the total cost of milling for the year.

Taxes are paid on a given date each year and are repaid gradually throughout the year. One-half the annual taxes is considered the proper working capital for this item.

The results by the two alternative methods above should check each other.

In any operation where income is not received regularly, the accumulation and subsequent release of working capital is equally irregular. This is characteristic of the operation of log driving in which operating costs mount steadily until the logs reach the market once a year, and the amount of working capital is greatest just before the end of the drive. The old time-check system of paying woods labor at the end of the season in checks payable at a future date, coinciding approximately with the receipt of this income, was merely a device to force the laborer to carry that portion of the working capital represented by wages, thus reducing the amount borne by the operator. In appraising such an operation, the average working capital for the year must be derived by first computing the amount needed each month, by tracing outgo and income.

E. g. In a cut of 20,000,000 feet annually it is assumed that stumpage payments at $2.20 per thousand, average as of January 1; that logging costs, at $4.00 per thousand, average as of February 1; that driving costs, at $1.00 per thousand, average as of May 1; and that milling costs, at $3.50 per thousand, average as of July 1. Sales at $15.00 per thousand feet begin in August. The sale of 2,000,000 feet is credited to the 1st of September and each of the succeeding nine months.

The working capital required to carry this business would then be:

For	Balance between outgo and income for the year	Balance from preceding year	Working capital for the month
January	$ 44,000	+$64,000	$108,000
February	124,000	+ 34,000	158,000
March	124,000	+ 4,000	128,000
April	124,000	— 26,000	98,000
May	144,000	— 56,000	88,000
June	144,000	— 86,000	58,000
July	214,000	.....	214,000
August	214,000	.....	214,000
September	184,000	.....	184,000
October	154,000	.....	154,000
November	124,000	.....	124,000
December	94,000	.....	94,000
Average	.....	.....	$135,167

Or 63 per cent of the total annual producing cost of $214,000. Ten or 15 per cent should be added to this total for safety.

The figures in the first column from January to August are the accrued costs of stumpage, logging, driving and manufacture. The figures from September to December and in the second column from January to March represent the accrued costs less sale receipts. The second column figures from April to June represent the surplus of sale receipts over accrued operating costs. The figures in the third column represent the capital required to carry current operating costs each month in the year.

No appraisal which confines working capital to the amounts actually demonstrated as above is safe. Working capital represents the cash margin for all unforeseen contingencies as well as current expense. For this reason, *from ten to twenty per cent must be added* to the apparent volume of working capital to obtain the total actually required as part of the interest-bearing investment.

In any operation the amount of working capital required will normally fluctuate, reaching a peak at certain seasons and diminishing to a low ebb at other times. Except when the nature of the operation itself is irregular as exemplified by the driving of streams, business custom carries this peak load by short term borrowing, or, in case sufficient capital is available to carry this

load, the surplus in the dull season is withdrawn for other temporary uses.

153. **Overrun.** — Logging costs are pro-rated on the log scale, and milling costs on lumber tally. Since the appraisal is to determine the value on the stump and the unit of measurement for standing timber is the log scale (§ 138), all milling costs and the price of the product are reduced to log scale by multiplying by 1 plus the per cent of overrun.

Let it be assumed that logging costs $4.00 per thousand feet log scale and depreciation $1.00; that milling costs $5.00 per thousand feet of lumber; that the average selling price is $15.00 per thousand feet of lumber; and that the overrun is 15 per cent. Then:

Logging 1 M log scale	$4.00
Depreciation on 1 M log scale	1.00
Milling 1,150 feet of lumber (1 M log scale) at $5.00 per M	5.75
Total costs	$10.75
Price of 1,150 feet of lumber (1 M log scale) at $15.00 per M	17.25
Margin for stumpage price and for profit and risk per M log scale	6.50

The per cent of overrun is best obtained by special mill tally checks against the log scale in use as applied by local custom or prescribed rules for scaling. General comparison of the cut for the year against the scale on the mill deck is a rough check. So many factors may affect the overrun that an accurate determination is never possible, and with some log rules such as the Doyle, it varies chiefly according to the average size of the logs sawed. Overrun will therefore be checked and roughly standardized for the type of mill used, the log scale, the scaling practice, the average sawing practice, the average length and diameter of logs sawed, and the form of the product.*

The per cent of overrun is of great importance in stumpage appraisals. In effect, it means that logging costs per unit of actual sawed contents are lower than shown on the basis of scaled log contents, and this margin, just as with any other saving,

* Chapman's Forest Mensuration, Chapter V, pages 46-49.

gives an equivalent advance in stumpage value. In the above example, this increase for a 15 per cent overrun is $2.25 — .75 = $1.50 or on $5.00 stumpage, 30 per cent increase in price. As the margin for stumpage decreases it may come about that the entire value of stumpage is due to the overrun. One large element in overrun is the manufacture of lumber from unsound material, selling as low grades. Scaling is usually based on a standard of sound lumber which excludes these grades, hence their tally in the output will increase the overrun, which would otherwise be confined to deficiencies in the log rule, use of thin saws, lumber from slabs and taper, thick dimensions or other factors affecting sound lumber.

Where average lumber prices include those paid for these low grades *it is necessary to include them also in the overrun.* The effect of including low grades upon the average price of lumber is the same as that shown for stumpage prices in Fig. XV. It slows down the increase in the average price, which price would not reflect the increase based on identical grades.

When the stumpage prices are readjusted in long term sales, either the revision must be based on lists of grades identical with those accepted in the original appraisal or else if lower grades are included in this revision of price they must also be included in a revision of overrun, in which case stumpage values will be given an increase reflecting both the advance in price of lumber and more intensive utilization of the tree. In reappraisals there is opportunity to correct the overrun figure used in the original appraisal.

CHAPTER XVII

MARGIN FOR PROFIT AND RISK, AND STUMPAGE VALUES

154. Margin for Profit and Risk. — The steps in the appraisal of stumpage value covered so far are, first, the determination of gross income based on the price of lumber, and second, the total of operating costs and depreciation. This involves, third, determining the amount of the capital investment including fixed investments and working capital.

Deducting these costs from income leaves a margin, which in stumpage appraisals must now be divided between the operator and the owner of the stumpage. In the method of appraisals described in the previous chapter, this margin has been found by deducting all costs which can be determined and appraised. Both these prospective costs and the probable income are based on present prices or averages of recent prices.

An actual cash profit is earned when income exceeds operating costs plus depreciation charges and leaves the working capital intact. Profit, being a future element representing a margin, cannot be appraised with accuracy on account of the ever-present element of risk. Therefore, the margin allowed for profit must be increased to cover this normal risk, or else the realized profit will in most cases fall below that allowed in appraisal.

This margin allowed the operator then contains two elements, namely, the return to capital, and the reward to the entrepreneur, which covers the provisions against normal risk. The return to capital as such will equal the average rate of interest on loans for such enterprises, which is influenced by the hazards of the business, since some portion of the risk attaches to losses as well as to the investor's capital. This should be at least six per cent. All the capital invested, whether borrowed or not, is entitled to the prospect of this annual return at simple interest, out of this margin.

The reward to the entrepreneur may be divided into that portion to which he is entitled for his personal services and managerial skill, and the reward earned by assuming risks.

In small undertakings where but little capital is invested,

interest is not a large item, and the profit depends largely on the personal efforts of the manager or owner. Individual energy and initiative count for more in temporary or shortened operations than in large sales of any duration. In new enterprises with an organization to create and market to develop, under special conditions requiring exceptional experience or business capacity, a larger allowance must be made. This element is relatively unimportant in large operations well organized along established lines.

155. Risks. — By far the larger element entering into the entrepreneur's gain is the reward contingent on the assumption of business risks, which he stands to lose if these circumstances go against him. These risks are larger in the lumber industry than in most other lines of enterprise. They combine the chance of lower market prices and higher costs with a high percentage of unforeseen losses and accidents caused by natural forces or incident to logging under difficult conditions. Accident or loss to bridges, roadbed or mills involves tying up the operation and incurs excessive business losses. Inability to drive a stream due to exceptional drought is an example of business loss involving working capital and mill shut-downs. Special risks due to physical factors of the particular chance must be considered in fixing the margin.

Risk on fixed investments and working capital. Ordinarily, and particularly with new enterprises, the risk on working capital is less than on fixed investments. The latter are not merely liable to physical damage, but may become a total or partial loss if the enterprise fails. Working capital, which is represented at any given time by logs, lumber, bank account, bills receivable, and stumpage deposits, is subject to reduction but is seldom subject to total loss, as is the investment in the grade for a logging railroad if the business proves to be a failure. Lumber and log stocks can usually be realized on and outstanding accounts can be collected. Hence in business practice a smaller rate of profit margin is sometimes figured upon working capital than upon fixed investments.

With well-established business undertakings, however, the risk on the working capital may be greater than on the fixed investments. The working capital at any given time may be largely represented by expenditures for labor, and a marked decline in

the value of the product may not only wipe out the expected profit but may also cause a loss, which loss takes the form of a reduction in the working capital. The fixed investments would not be lost as the result of such a temporary lack of proportion between labor costs and selling prices.

The relative risk to the fixed investments and to the working capital should be recognized either by separate treatment or in the average rate of margin for profit and risk.

Other factors affecting risk. In the consideration of timber chances, operators must also take into account possible overestimates of the quality of the stumpage or the selling price of the various lumber grades and possible underestimates of necessary investments or operating costs. The size and permanency of the operation are important factors. Large investments carried for long periods, like railroads and modern office buildings, are satisfied with a lower return than smaller, less stable enterprises. Operators with established markets and transportation facilities will accept a lower return than where these features of the business must be constructed or developed. All of these are factors of risk which must be weighed by the appraiser in determining the margin which should be allowed.

Comparison with other kinds of business. The lumber business involves greater risk and uncertainty than most manufacturing enterprises. Industries characterized by permanence and physical safety of investments, standardized processes, and assured markets are run on a margin of profit which would be wholly inadequate for lumbering. Its general conditions are entirely different. Each operation must be adapted to the topography of its chance. New methods must often be developed and applied to peculiar local conditions. Exactness in estimates of investments and operating costs is practically impossible.

The capital invested in fixed improvements is subject by their nature and location to a fire risk which cannot be as fully insured against as in most comparable lines of business. The work is hazardous and injuries to workmen are frequent. The hazard from unusual climatic conditions is greater than in most manufacturing industries. Losses due to uncontrollable causes, such as car shortage and bad accounts, are common. As in other enterprises, the business is subject to labor troubles and breakdowns. It is dependent upon unskilled labor to an exceptional

degree. All of these tend to make a high margin for profit and risk necessary.

Operations on publicly owned forests have certain financial advantages when compared with private lumbering. The system of small payments amounts in long-time sales to a substantial saving of interest and taxes. The effect of this, however, is upon cost of production, not upon certainty of profit.

Operators in public forests, however, have some advantages over private lumbermen in the matter of risk. Owning no timber, they have a smaller total investment, and consequently less to lose if the enterprise is a failure. Since title to the timber does not pass until it is cut and scaled, they run much less risk of loss from fire.

On the other hand, contracting to log under public supervision necessarily involves a risk, however small, which the operator on private land avoids. Furthermore, the purchaser of public timber foregoes to a large extent speculative profits from increased stumpage and lumber values and from overrun, both in estimate and scale.

The risk of failure to secure sufficient public timber to depreciate the investment, by being obliged to compete for additional stumpage, on the one hand, and of submitting to a reappraisal of stumpage value in case this supply is contracted for, on the other, is offset only by confidence in the stability, fairness and efficiency of administration of public service.

156. Basis for Computing the Margin for Profit and Risk. — The margin for profit and risk must always be expressed in terms of units of products in common with costs and price of the products, and reduced to log scale in case of lumber output. E. g., sale value of lumber reduced to log scale, per thousand feet, $40.00: costs, $30.00, margin for profit and risk, $6.00, residual margin for stumpage, $4.00.

In determining at what figure this margin for profit and risk shall be set, there is a choice of two methods of procedure. If the capital investment is large compared with personal services of the owner, this margin should be based on the annual rate to be earned on the investment, including interest, and entrepreneur's hoped-for gain which is the risk margin. These elements are not separated.

The amount per unit is found by dividing this sum by the

annual output. E. g., if $100,000 is required to furnish an appraised margin of 20 per cent on total capital of $500,000 for a plant and operation cutting 30 million feet annually, the charge for this item is $3.33 per thousand feet.

This process of calculating the margin for profit and risk is termed the investment method.

If, instead, the required sum is determined directly as so much per unit of output, the process is reversed and the sum which may be earned during the year is then made to depend in turn on the quantity of output multiplied by this item. E. g., a profit and risk margin of $3.50 per thousand feet is allowed on a sale of 5,000,000 board feet. This gives a total margin for profit and risk of $17,500 for the operation, which if spread over three years would be $5,833 per year.

This process is termed the overturn method, since the margin for profit and risk is based primarily on the return allowed to working capital each time it is risked in the business or turned over. If the proportion of working capital to total investment is large and the turnover is rapid, the total annual profit on the capital invested may be considerable even when the amount or rate earned on each turnover is low.

The investment method is preferred and used whenever possible, as the most reliable means of appraising the margin required for profit and risk. When the average profit-bearing investment is too small to offer a satisfactory basis of capital on which to calculate this margin, the overturn method may be substituted.

The profit margin allowed by this method should be compared with that earned by going operations, by the results obtained in operations based on previous appraisals, by margins indicated through prices bid on similar sales and by the flat profit per thousand feet which the method yields for the appraisal in question as compared to other operations.

157. Stumpage Value by Overturn Methods. — Logging costs may be separated from milling costs in applying this method, thus permitting the calculation of a separate rate of profit on each part of the enterprise. The rate allowed on logging should ordinarily exceed that on milling, due to the greater risk involved.

By the standard overturn method, profit is a per cent of the

overturn, i. e., of the total cost of producing a thousand feet of lumber exclusive only of the stumpage price.

Let Lc = logging costs.
Mc = milling costs.
D = depreciation { Ld for logging. / Md for milling.
S = sale value of lumber or of logs.
P = Profit.
X = stumpage value of 1000 board feet of manufactured lumber.
q = per cent of overturn representing margin for profit and risk.

Then $P = q\%(Lc + Mc + D)$
$X = S - (Lc + Mc + D) - q\%(Lc + Mc + D)$
$= S - (1 + q\%)\ (Lc + Mc + D)$

The basing of an appraisal of margin for profit and risk on average costs has no resemblance to the so-called "cost plus" method of allowing profits on the basis of actual operating costs. The latter puts a premium on extravagance, and rewards inefficiency. The use of appraised average costs and profit and risk margin in advance of operation has the opposite effect, for while it insures a reasonable profit to an average operator, the extra gain due to skill and enterprise can be obtained while the less efficient operator is apt to lose his profit and be eliminated. Where it is desirable to allow separate rates on logging and milling costs let r = per cent of overturn in logging. Then

$P = q\%(Mc + MD) + r\%(Lc + LD)$
$X = S - (Mc + MD + Lc + LD) - q\%(Mc + MD) - r\%(Lc + LD)$

Since the profit margin is to be allowed for each thousand feet or unit produced, it is earned each time the working capital is turned over. The more frequent this turnover the larger the total sum allowed per year as profit for a given per cent on overturn. This per cent must therefore be less for short turns than for long.

Rates of Profit Margin Under the Overturn Method. The percentage of overturn used in computing the profit margin should therefore be gauged by the risk, the frequency of the turn, the permanency of the operation, and the local requirements and standards of the particular business. For tie and mining timber

business operations, with the cut contracted in advance and the market risk thus eliminated, 20 per cent may be taken as standard if the turn is only once or sometimes twice a year and the chance involves no unusual logging hazards. With several turns a year, but other conditions as given above, 12 to 15 per cent is usually sufficient for operations extending over several years. Short operations often require higher rates. In saw-timber sales subject to the usual market risks, as when all or most of the output will be sold as produced instead of under a contract made previously, a rate of 20 to 25 per cent should be used under average conditions with a turn of less than three times a year. If inaccessible timber must be opened up, exceptional risks incurred in logging or stream driving, or unusual problems in marketing met, a margin for profit and risk of 30 to 35 per cent is equitable, especially if the turn is expected to be only once a year.

In every case, the rate should be checked by the amount of margin in money terms to make sure that equitable allowance has been made for the risk in the labor and market situations applicable to the chance. In small operations where the return will be regarded chiefly as compensation for personal services, the amount of the margin in terms of money should be considered with regard to its adequacy for this purpose, with an additional return on the actual overturn.

158. **Modifications of the Overturn Method.**—The rate or per cent of overturn chosen to determine profit based on the overturn or total cost per unit can readily be expressed as an equivalent per cent of average selling price instead, if it is assumed that the investment per unit in stumpage is also entitled to share in this profit, a point which the first method overlooks. Under this modification $q' =$ per cent of selling price representing margin for profit and risk,

Then $$P = q'S$$

If q is the per cent of costs, including stumpage, to be allowed, e. g.,

if $.0q = 20,$

then $$.0q' = \frac{20}{1 + .20} = .16\frac{2}{3}$$

$$= 17\frac{1}{2}\%$$

$$= 16\frac{2}{3}$$

Stumpage value is found as follows:

$$\begin{aligned} X &= S - q'S - (Lc + Mc + D) \\ &= \frac{S}{1+q} - (Lc + Mc + D) \\ &= S - (Lc + Mc + D) - q\%\,(Lc + Mc + D + X) \end{aligned}$$

This profit is greater than that by the overturn method by the amount of $q\%\ X$, which would indicate a reduction of q below the equivalent shown. There is no particular merit in substituting this method, since it requires the same basic data as for the standard method.

A second modification of the method is practicable when payment can be postponed until after the lumber or products are sold. By previous agreement between operator and owner the margin between income and costs may be divided on a percentage basis, the owner's share representing stumpage prices. This gives the owner a share in any profits due to changed economic conditions affecting markets or costs, and he shares proportionally with the operator in the losses due to unforeseen costs, and the gains due to efficiency. This is essentially a risk-and-profit-sharing plan, feasible for small operations where accurate books are kept and there is sufficient mutual confidence to justify it. Under this plan,

$$P = S - (Lc + Mc + D)q\%.$$
$$X = S - (Lc + Mc + D)(1 - q)\%.$$

159. **Investment Method.**—By the investment method the margin for profit and risk is reckoned as a per cent of the capital invested, including fixed investments and working capital. The most accurate mathematical basis is to determine for each year separately the total investment and the required margin. But this does not conform to normal business practice or to conditions in the lumber industry, where there is heavy depreciation and the peak of the capital investment is reached in the first stage of the operation, while profits increase towards the later years with the reduction of this investment.

For this reason, and because of its greater simplicity, the method recommended is to base the margin on the average investment during the life of the operation. The investment basis gives a result which is independent of the frequency of the overturn on

working capital, and is based instead on the amount of such capital required in addition to fixed investment. Then, if

A = fixed investment, average for period.
W = working capital, ditto.
q = per cent margin for profit and risk.
P = annual sum required.
Then X = stumpage value.

$$P = q\%(A + W).$$

$$X = S - \left[Lc + Mc + D + \frac{q\%(A + W)}{\text{annual cut}} \right].$$

In an operation cutting 10,000,000 feet annually the estimated average investment, including working capital, is $235,000 and the annual depreciation $12,000. Logging costs $6.00 per thousand feet log scale and milling $4.50 per thousand feet, lumber tally. The overrun for the class of logs involved, yellow pine running 10 logs per thousand feet, is 20 per cent; and the average selling price mill run, lumber tally, is $16.00. The operation involves comparatively low risks, the timber being cut by an established mill with well-developed markets. A return of 15 per cent on the investment is deemed equitable. The elements in the formula are thus:

Selling price (1,200 feet at $16.00 per M) ...		$19.20
Logging costs	$6.00	
Milling costs (1,200 feet at $4.50)	5.40	
Depreciation ($12,000 ÷ 10,000 M)	1.20	
Margin for profit and risk (15 per cent of $235,000 ÷ 10,000 M)	3.52	
Total charges		16.12
Stumpage price		$3.08

Rates of Profit Margin Under the Investment Method. For a lumbering operation of good size, extending over a period sufficiently long to reduce the average risk to working capital from sudden fluctuations in the price of the product, 15 to 20 per cent on the average annual investment is a fair margin for profit and risk. Lower rates of margin should be used in appraisals only when the prices bid in current sales of similar timber show that

operators consider smaller rates of margin are justified by the conditions in the region. On chances tributary to established plants which are in a position to purchase them, in regions where logging involves no extraordinary problems or unusual risks, and where the risk to the enterprise is low because of well-established markets, 15 per cent should be the general standard. If the business enterprise is new and recognition must be won in the market, but other conditions are as above, the rate of margin may properly be extended 18 to 20 per cent. If the industry is to be developed largely under new conditions, as when the product must win a place in the market against the custom of trading with older producing regions, or if special risks exist in logging, a rate of margin of from 20 to 25 per cent may be equitable.

As a rule, chances suitable for relatively short term, medium-sized operations should be appraised with a rate of profit margin from 2 to 5 per cent higher than is used for large chances under similar conditions of physical risk and general marketing conditions. This is because of the greater risk from an unexpected market depression, which may impair the working capital or even imperil the enterprise without the opportunity of the long operation to recover such losses when the depression passes. The higher rates should not be used if it is customary in the region for the product to be sold at a fixed price, as under a contract for the entire output of the operation.

Different Rates on Different Parts of the Investment. The risk to which different parts of the investment in a lumbering operation are subject may vary within considerable limits. Practically no risk, for instance, attaches to investments in land for mill sites. Risks are frequently less in manufacturing than in logging operations, the latter being conducted under more hazardous physical and less stable labor conditions. Working capital may be subject to greater or less risk than fixed investments, according to conditions. Investments in main-line railroads which will be maintained as common carriers after the chance is logged out are subject to less risk than investments in temporary railroads.

Where existent, differences in the risk in the investments for manufacturing and for logging, in working capital, and in main-line railroads should be recognized by separate rates, or the appraiser should indicate clearly the effect of the variations in risk on his choice of an average rate. Under optimum to average

manufacturing and marketing conditions a return of 10 to 15 per cent on the manufacturing investment is considered reasonable. Since physical and business risks are practically eliminated, a low rate of profit margin from 8 to 12 per cent, according to the prevailing rates on short term loans, is often adequate for that portion of the working capital represented by accounts receivable or stocks sold but not paid for. A return of 10 to 12 per cent on the investment in railroads for which permanent traffic is anticipated is reasonable. Otherwise no distinction should be made in the rate of margin for profit and risk allowed on various parts of the total investment, although divergent degrees of risk, such as for the investments in mill sites as compared with the working capital necessary for logs and lumber on hand, should be considered in choosing an average rate of margin for the remaining investment.

160. Application of Method to Mixed Stands. — In a mixed stand containing two or more species, the sale value of the products of these species usually differs considerably. Often only one valuable species will be removed from a mixed stand. As values increase, other species become profitable and finally, all may be taken.

At a point just before the inferior species become sufficiently valuable to be logged, the operator is under the necessity of constructing his transportation system and incurring his entire cost for equipment and overhead expenses in order to log a portion of the stand, thus moving a smaller volume of lumber at relatively greater expense per unit.

Assuming that the total costs, including depreciation, amount to $12.00 per thousand board feet and the most valuable species is worth $20.00, the margin for profit and risk and for stumpage is $8.00. A species worth but $12.00 on the market could apparently not be marketed at all. But there is very little additional investment involved in logging this second species. By doing so, the total average cost of logging might be reduced by lessening the average of overhead charges and the depreciation to $10.00 per thousand feet for the entire operation, by distributing these costs over a larger volume of output. This adds a profit of $2.00 to the more valuable species, and leaves a margin of $2.00 for the inferior one, for profit and stumpage.

Such a cost distribution is unfair to the inferior species, since

the operation does not depend on its presence and the capital expenditures must be incurred without its inclusion. It has been suggested that the more valuable species or group be made to bear both the entire cost of depreciation, which represents the capital expenditures, and the overhead charges. The inferior group is left to bear merely its proportion of operating costs. This plan is rather crude where there are several species, all of different values. Instead, each species may be made to bear a fair proportion of the depreciation and margin for profit and risk by determining for the separate species the difference between selling price and operating cost. To the sum required annually for the margin for profit and risk, the annual depreciation is added. This total is then prorated as a charge against each species based on the above difference or margin, and proportioned to the percentage of the species in the total cut. This plan prorates the depreciation and margin for profit and risk on the basis of value in dollars represented in the total cut by each species after it has met its own operating costs.

A yearly cut is made up of 4,000,000 feet of sugar pine, 3,000,000 feet of yellow pine, and 2,000,000 feet of white fir. The margins between selling prices and costs of production, exclusive of depreciation and profit and risk margin, are:

Species	Selling price	Operating cost	Margin
Sugar pine	$20.00	$10.00	$10.00
Yellow pine	18.00	10.00	8.00
White fir	15.00	9.00	6.00

The total net value, or sum of the margins, over which depreciation and margin for profit and risk may be prorated, is thus:

Sugar pine $10.00 × 4,000 M	$40,000
Yellow pine, $8.00 × 3,000 M	24,000
White fir, $6.00 × 2,000 M	12,000
Total	$76,000

The annual depreciation and margin for profit and risk (using investment method) which must be paid out of this total has been computed as $34,200. Hence $\frac{\$34,200}{\$76,000} = \$0.45$. That is, every dollar of the difference between operating costs and selling price must pay 45 cents toward profit and depreciation. The

following charges per thousand feet for depreciation and profit margin, by species, are thus obtained:

Sugar pine, 10 × $0.45	$4.50
Yellow pine, 8 × $0.45	3.60
White fir, 6 × $0.45	2.70

By this method inferior species which yield no margin between operating costs and selling price, or a negative margin, but which must be included in the sale for silvicultural reasons, are automatically relieved of profit and depreciation, and the charge upon the other timbers for these items proportionately increased.

The same result is readily obtained on a thousand-foot basis, using the per cents of the different species in the cut. That is, to obtain the average margin:

45 per cent sugar pine at $10.00	$4.50
33 per cent yellow pine at $8.00	2.64
22 per cent white fir at $6.00	1.32
Total	$8.46
Depreciation and profit margin per M feet	3.80

$\frac{\$3.80}{\$8.46} = \$0.45$, to be taken from each dollar of gross margin for these items.

161. Stumpage Values in Mixed Stands. — In mixed stands the inferior species not only averages a lower selling price but may also incur a smaller milling cost, since they are not put through finishing grades. Based on the above treatment, the stumpage value of each species is derived directly from its own selling price. Differences in stumpage value require the separation of species in the log scale. This, however, is preferable to a flat rate even though the latter can easily be computed from the proportion of each species in the estimate, since the estimated volumes of the different species may be in error both as to total volume and proportion of species in this total. If the flat rate is based on an overestimate of the per cent of the more valuable species, the buyer loses, while if the less valuable species are given undue proportion the loss falls on the seller. By pricing each species at its real worth this element of speculation and uncertainty is avoided.

Use of Minimum Stumpage Rates. The appraisal of inferior species not infrequently results in very low or negative stumpage prices. On the National Forests it has been deemed advisable to establish a minimum rate of 50 cents per thousand feet for green timber, below which no species will be sold. Inferior species are therefore appraised on their own merits as determined by lumber price and cost of production as long as the resulting stumpage value is not less than 50 cents per thousand feet. If the calculation brings the price below 50 cents, the appraisal is at that figure. The prices put upon the more valuable species in the stand are then reduced sufficiently to carry the difference and maintain the average profit which is deemed equitable on the entire cut which the purchaser is required to take. Optional material is not included in the computations.

Distribution of Loss on Inferior Species. Such adjustments in the stumpage rates of various species may be made by a simple arithmetical process, as follows:

It is assumed that separate appraisals, on individual lumber price and producing cost, give the following stumpage rates in a mixed stand of California timber:

Sugar pine (30 per cent of the cut)	$5.00
Yellow pine (35 per cent of the cut)	4.00
White fir (20 per cent of the cut)	.20
Incense cedar (15 per cent of the cut)	.10

By appraising white fir and cedar at the Service minimum of 50 cents, the amount to be made up on the other species, thousand feet for thousand feet, is 20 per cent of $0.30 + 15 per cent of $0.60, or $0.15. This amount will be spread over the sugar and yellow pine prices; that is, 30 per cent of $5.00 + 35 per cent of $4.00, or $2.90, $\frac{\$0.15}{\$2.90}$ = approximately 5 cents, to be deducted from each dollar of stumpage value in the pines. The adjusted rates are therefore:

Sugar pine	$4.75
Yellow pine	3.80
White fir	.50
Incense cedar	.50

This method is used only when necessary, after margin and depreciation have been prorated on value, to maintain the minimum price.

If only two species are involved, the calculation may be made by multiplying the loss per thousand feet on the inferior species by the percentage that species is of the total cut, and then dividing the product by the percentage of the total cut which will be of the better species. The result is the amount to be taken from the indicated price per thousand for the more valuable species.

Trade Valuation of Inferior Species. The stumpage rates placed upon inferior species should be checked by trade practice and valuation. Consistent and practical results are desired, conforming as far as possible with the rating of such timbers by local operators. Standard prices for low grade species representing the operator's valuation and not below the minimum rate may be used throughout a region if found to be most practicable and satisfactory. In any event the prices of the better timbers should be adjusted to yield the total margin for profit and risk called for by the appraisal.

162. Special Products and Small Sales. — *Stumpage Prices for Special Products.* The methods of appraisal previously discussed should be used where the main products of an operation are other than lumber as shingles, crossties, poles, or mine timbers. Average selling prices should be determined for the product in the form in which the usual operator disposes of it, as manufactured shingles, hewn or slabbed ties, etc., and operating costs back to the stump, depreciation and profit margin estimated. Rates of margin for profit and risk similar to those discussed for saw-log sales should be allowed in operations of similar size, conditions of accessibility, operating difficulties, and risks, except where other rates have been indicated.

Stumpage rates for special products should be based as far as possible upon the unit of measure common in local trade, as the piece in case of poles and crossties, the linear foot for mining timbers, the stacked cord for shingle bolts or fuel, etc.

Small operations are seldom as closely organized and well supervised as those of good size and permanence. Equipment is usually less efficient, capital inadequate and labor frequently unskilled and transient. Hence costs are least uniform in small operations and nearly always higher. Care must be taken in such

appraisals not to impose impracticable standards, but to figure on the level of the conditions found in that region for that type of operations.

Appraisals in small operations should be fixed upon the methods of logging and manufacture actually employed, even if comparatively inefficient. As far as practicable, small mills should be classified by output and average costs determined by classes, which cover existing conditions as to character of labor available, amount of capital upon which the business is run, and the kind and efficiency of equipment.

Such average costs may be used in appraisals when desirable with only such variations as the particular conditions on each chance require.

The lumber prices used in such appraisals will similarly be the local prices actually obtained by these small operators, unless the region is so isolated that outside timber does not compete with the local timber. In the case of public timber the lumber price may then be based upon the rates obtained for similar material in other portions of the region where competitive conditions exist.

For small operations whose product is sold in general markets in competition with large plants, the average lumber prices prevailing in such markets would necessarily be taken as the basis of appraisals. The grade and quality of the product, which is usually poorer than lumber manufactured by large mills, should, however, be considered. Otherwise the policy indicated above as to efficiency of methods and labor and scale of profits should be followed.

Investments should be estimated and appraisals made on the basis of small operations wherever it is practicable for them to handle the timber.

If large operations are clearly more practicable and logical, however, and the timber has been appraised accordingly, the resulting prices must be paid by any purchaser who takes the stumpage. Two standards of value obviously can not be set for the same material. Under such circumstances no concessions to the inefficiency of the small operator can be made.

163. Form for Summarizing the Essential Data in Stumpage Appraisals. — The use of the following summary in outline form is desirable to present concisely the more essential features of the appraisal.

1. The sale area.
   - (1) District, forest, main watershed or other descriptive location, designation of sale or chance.
   - (2) Area covered by appraisal (acres).
   - (3) Distance from chance to common carrier, or local market, by proposed logging road, flume, drivable stream, etc. (method of transportation and miles).
   - (4) The stand:
     - (*a*) Total estimated cut (thousand feet).
     - (*b*) Name and per cent of each species.
     - (*c*) Kind and per cent of each product to be cut (saw logs, ties, mine props, etc.).
2. Investments.
   - (1) Name main units (railroad or flume with length, sawmill with capacity, etc.).
   - (2) Average fixed investment (profit-bearing).
   - (3) Annual depreciation.
   - (4) Average working capital.
   - (5) Total average investment in operation.
3. Cost of production (per thousand feet log scale, piece or other unit; separately by species or products as required).
   - (1) Depreciation.
   - (2) Logging.
   - (3) Manufacture.
   - (4) General expense.
   - (5) Silvicultural requirements.
   - (6) Total.
4. Profit margin.
   - (1) Estimate of risk (low, average, high).
   - (2) Method used (investment, overturn, pay for personal services).
   - (3) Rate.
   - (4) Profit in dollars and cents (per thousand feet log scale or other unit of output).
5. Selling price (per thousand feet log scale, piece or other unit; separately by species and products as required).

6. Recommended stumpage price (per thousand feet), log scale, piece, or other unit; separately by species and products as required).

7. Important contract terms.
   (1) Cutting period.
   (2) Construction period.
   (3) Other terms which materially influence the appraisal.

164. Appraisals for Purchase of Stumpage.—The same principles apply to appraisals for purchase of stumpage as for sales for immediate cutting. The object of purchase is usually to assemble a body of timber as a forest estate, or in private operations, to guarantee the timber necessary to spread depreciation over an adequate period.

Market value is paramount in such appraisals and should be ascertained from any available source. A check on this value may be made, for the purchaser's benefit, by the methods outlined in this text, to obtain present sale value as a basis from which to make deductions in appraising a fair maximum purchase price. These deductions consist of the cost of selling the timber, the cost of carrying it over a period of holding, including taxes and protection, and the cost of purchase and assembly. This cost may run as high as 20 per cent of the sale value, where tracts are small and scattered. Interest is usually deducted in such an appraisal, and a further discount of at least 10 per cent should be made for a safety factor in approximating the price which may be bid for the property.

If the market price proves to be less than this appraisal, the buyer is correspondingly benefited, and if more, he will not realize his interest. The justification of such discounts is that the purchases occur previous to the initiation of cutting. Going concerns can and do pay more for stumpage picked up after the plant is in operation.

Timber Rights. The purchase of stumpage for future cutting may or may not carry with it the acquisition of the land. If acquired for forest production it will always do so. If bought by operators whose interest lies solely with the logging and milling, the acquisition of timber rights only is considered advantageous. The former owner is left in possession of the land and usually has to pay the taxes. Thus there is no land problem

when the tract is cut out. The only difficulty lies in the time limit placed on the right to cut. These rights sometimes cover periods of twenty years but only when the owner is not advantageously represented in the transaction.

The chief difficulty arising over timber rights is in the definition of what has been purchased. This hinges first on the meaning of the term "merchantable" which can be overcome by fixing a diameter limit. For this the stump is chosen, as remaining in evidence, but the lower it is cut, the larger diameter and the more trees may be taken for a fixed limit. A still greater difficulty is the ignoring, either through carelessness or deliberately, of the factor of growth or increase in diameter during the period covered by the timber right. This applies whether the timber has been purchased on a "merchantable" basis or on a diameter basis. Are trees which at the time of purchase were not within the classes covered by the agreement but which during the period reach such sizes, included in the contract? This question is more serious when a lump sum has been paid for the timber at time of purchase as is usual, than when it is paid for as cut. The question is seldom specifically stated in such agreements.

Hence, the courts are called upon to interpret their meaning. Where the contract calls for only such timber as was of specific sizes at the time of purchase, it becomes necessary to make studies of growth to find out what trees have been cut which when the tract was bought were under the minimum size. As the growth rate of different species and individuals varies it is not possible for a logger to know in advance what trees he owns. Hence the best form of contract is one which prescribes a flat diameter limit, which should preferably be based on a uniform point at 4½ feet above the ground, or else a fixed stump height, and states that all trees which reach this size during the period shall be included in the purchase. If a lump sum is paid for the purchase, this price can be increased sufficiently to cover the prospective value of the timber now below merchantable size.

CHAPTER XVIII

TAXATION OF FOREST PROPERTY

165. Forests as Taxable Wealth. — Taxes are based on value, and not on cost. The value of forest property for taxation when the property tax is applied is the value of timber plus soil.

Timber may be regarded as accumulating income on soil as capital (theory of soil rent § 68), or as a part of the forest capital (theory of forest rent § 67). In either case it constitutes taxable wealth. Whether it should be taxed as such depends on the condition of the timber, and the public good. When it has reached maturity as a timber crop the forest should be in condition to become a going concern, and the timber can be regarded as wealth taxable under the forest rent theory as a part of the value of the property; but when this timber is still immature, the value that it gives to the land is greater than the separate value of the trees. The income is prospective, its value derived by discount (§ 27).

Such growing timber resembles the interest on a capital fund (land) which is saved or hoarded, but without the possibility or alternative of spending or reinvesting it separately from that of the land value. The policy of taxing this value is akin to that of taxing savings or penalizing attempts to create future wealth or build up industry.

166. Income Taxes versus Property Taxes. — Taxes may be classed as income taxes based on gross or net income or on profits, and property taxes based on value as assessed for the purpose. These classes of taxes differ in form, in method of assessment and collection and in their effect on the net income and value of property, yet fundamentally they must be derived from the same final source which is net operating income or the earnings of capital (§ 41).

The value of products measures the value of income, and this in turn gives value to capital (§ 90). A tax laid on income has its equivalent in a tax on the capital which produces the income.

When income is earned annually and capital value is hence expressed as: $V_o = \frac{r}{.0p}$, this relation may be expressed as follows:

Let
$x =$ per cent of income taxed
$r =$ income
$t =$ annual tax

Then
$$t = r(.0x)$$
$$\frac{r}{.0p}(.0x) = V_o(.0x)$$
$$t = V_o(.0p).0x$$

The equivalent tax rate on property value is thus found by multiplying the rate of discount on which this property value is based by the rate of the tax on income.

E. g. On $100.00 income a tax of 20 per cent is levied, amounting to $20.00. Capitalized at 5 per cent the property is worth $2,000. Five per cent of 20 per cent is 1 per cent, which is the equivalent rate of taxing the capital value, yielding $20.00 as before. This gives a tax rate of 10 mills on full valuation of the property.

This equitable adjustment between income and property taxes is prevented by the imperfect coördination of the values themselves. Income is not regular nor in most cases continuous. The rate of discount fluctuates and is influenced by the market rate of interest, and the market value of property does not respond readily nor accurately to these two influences.

A tax on income requires the actual determination of this income and is capable of a very close approximation to the true proportion of value which it is intended to take, though it may involve greater difficulties of collection and will fluctuate from year to year to a greater extent than one on capital value. A tax on property is levied on a basis of fixed assessed value readjusted at intervals, and is easily administered and fairly certain in amount, but it is more difficult to adjust this tax so as to take the same per cent either of income or of capital value, due to the uncertainties and fluctuations of the discount rate.

167. **The Problem of Equalizing the Tax Burden.** — Taxes have for their primary purpose the production of public revenues sufficient in amount to meet the annual expenses of government.

These governmental activities are such as have proved to be necessary for the protection of society from its enemies, and beneficial to its progress. Hence they tend in all directions to conserve and to increase values by reducing risks and increasing efficiency of production at lower costs, and by improving markets.

The power to tax is inherent in the state or government as an exercise of the power of collective society, a burden on the individual imposed for the good of all, by which he in turn should benefit. The benefits of taxation to property owners lie in the theory that more net value is added to property by the proper expenditure of public revenues than is taken away by the taxes. If this were not so, taxes would amount to confiscation of a part of the capital value of property equivalent to that portion of the income taken, as shown by the relations above set forth. If 50 per cent of the income is taxed, then the net income is $r/2$ and its value is $\frac{r/2}{.0p}$. But, if in the absence of public improvements and protection the net income would be reduced to $r/3$, tax free, the owner is worse off, not better, for escaping taxation. The problem of taxation is first, to secure funds sufficient to enable the state to perform the functions which the people have determined upon through their legislative body, and second, to distribute the burden equitably among the people. A corollary of this latter objective is that the tax system shall conserve the sources of revenue so as to yield more taxes instead of less in the future. Inequalities of tax burdens arise from the complexity of the sources and kinds of taxable values and failure to arrive at equitable methods of adjustment. The effect of inequalities is to discourage the form of industry unduly taxed and to stimulate that which is more lightly taxed by setting up a flow of capital from one to the other following the tendency of investors to seek the greatest net returns (§ 70). Even though the industry which is over-taxed be vital to the future welfare of the community, as in the case of farming or forestry, this fact in itself does not avail to check the evil results of sustained tax discrimination which is a condition affecting the most sensitive regulator of industry, the returns to the entrepreneur (§ 21). Where the probable amount of income to be taken for taxes lies in the unknown future with no restraint or limitation on the taxing body, this condition constitutes a risk

of first magnitude deterring private entrepreneurs most effectually from such investments.

168. Present Tax Conditions on Timber Lands. — The problem of taxation of timber lands is of great importance for several reasons. Forest lands have in the past and may again in the future provide the source of a large proportion of the total tax revenues of towns, counties, and states, but bid fair in many localities to cease yielding such revenue and to prove a liability to these local governments instead, by exhaustion of the tax-producing forest capital and failure to restore it by the adoption of proper measures. In many districts the annual tax revenue from other sources is insufficient to support governmental activities and the town or county becomes bankrupt and loses its organization, becoming in turn a burden on the next higher unit or the state or public at large.

In the form of land, forest property is taxed on the basis of the general property tax which is the chief source of income to organized townships and any diminution or severe fluctuation of revenues from land taxes works a hardship on those least able to bear it. The effectiveness of assessment in securing this taxation of land values is estimated at between 50 and 60 per cent, while for personal property and intangibles it is between 15 and 20 per cent. This results in a tax burden on land which is about three times as heavy as on other forms of property. Reduction of taxes on forest lands would tend to raise taxes still higher on agricultural lands in the same township.

Wasteful and short-sighted methods of cutting virgin timber tend to destroy a taxable resource. These methods of cutting can seldom be attributed directly to high taxes, but instead frequently were an invitation to impose high taxes in response to a public desire to obtain as much revenue as possible from the timber before it disappeared forever. The false economic policy set up in this way led to extravagance in public expenditures and resulted in ruin on many cutover areas.

169. The Objectives of Reform in Forest Taxation. — Taxation is distinctly a question concerning public, not private welfare, but whatever cause works an injustice to individuals or to a class sufficient to drive them out of an industry or to diminish enterprise is a public injury of first magnitude.

The objectives sought in tax reform on forest property are, first, *the restoration or perpetuation of the forests through private agency* as contrasted to public ownership, but intended to secure the public benefits resulting from forest production; second, the perpetuation, restoration and increase of taxable values in forest property and of future income from taxation.

All forest tax relief measures should be judged by three standards.

1. Are the public interests safeguarded and conserved, both for the present and the future?
2. Does the measure aim merely at removal of actual inequality and injustice in taxing forest property as a class?
3. Is its intention frankly to encourage or stimulate the business of private forest production by the granting of special privileges or lighter tax burdens than the average resting on other property or enterprises, on the theory that forestry is a new enterprise beneficial to the public?

Public welfare and public sentiment demand that tax revenues be dependable in amount and regular in payment, that they be not materially decreased, and that forest property capable of yielding taxes shall be taxed (1). Present tax revenue outweighs future tax income in importance in the public mind. Such legislation must therefore avoid as far as possible diminishing the annual tax receipts of towns by reason of special privileges granted on forest property. It must continue to provide a basis of dependable annual revenue. Finally, it must permit of the *taxing of mature timber* on a basis equal to that of *other taxable property.*

Forests as going concerns do not require special measures as they are already established and can pay taxes from income. It follows that both objectives 2 and 3 mentioned above apply chiefly to *forests in process of restoration or creation,* so are difficult to separate. Just where the removal of inequality or injustice ends and actual concessions begin depends on one definite factor, namely, the *weight placed upon interest or discount or the theory of advance payments* (§ 173). This theory holds that since all tax revenue must ultimately be earned from income or else constitute in effect a confiscation of capital itself, injurious to society, the payment of taxes on property such as

growing timber, on which the realization of income is unavoidably deferred, constitutes an advance by the owner to the public of future income, in the form of annual taxes. Such an advance carries with it the same benefit to the public as the prepayment of a note due at a future date, and the taxpayer is entitled to the same reduction by discount on total cash taxes paid on the property represented by the timber crop, or income, as he would if he prepaid a note. Though the public on the one hand may desire to rehabilitate private forestry but on the other hand insists on taxing property in growing timber at its full value throughout the period of restoration or development, the private owner in turn will not be so willing to overlook this inconsistency, for to him taxes are actually an advance as stated and should be discounted if they are to bear a proper relation to future income. Such taxation is therefore wholly inconsistent with attempts to induce private capital to undertake forest production.

Any proposal for tax reform on forest property must be tested by the above three standards before its practicability can be fairly judged.

170. General versus Local Tax Reform. — The tax reform which would be most effective in forestry is the lightening of the general tax burden on land as contrasted with other forms of property and income. This must be accomplished by general tax equalization not specifically touching forest property. Unless such a reform is accomplished, *local* measures favorable to forest land are apt to prove reciprocally unfavorable to agricultural land in the same town until such time as the forest is again built up to full reproduction, by which time agriculture may have suffered a severe setback. In adopting measures intended to give relief to forest lands as such, provision must be made to safeguard the total tax revenues of the town and the interests of the remaining land holders. In the past this difficulty has been met through the exercise of the authority of local tax officials by the procedure of ignoring and nullifying the intent of such laws in various ways. This is why most relief measures have failed in the past, no matter what their form. Local governments are of course shortsighted in this matter, being unwilling to make sacrifices of revenue at present, or to shift the tax burden in case taxes cannot be reduced, and by such measures to lay up for themselves

or their posterity a greater potential tax revenue for the future by the creation of new taxable forest wealth.

Reform in forest taxation will therefore rest on two possibilities; first, education of public sentiment to encourage such sacrifices and adjustments, and second, more widespread participation in carrying the tax burden. The latter will depend primarily on general tax reforms but can also be directly applied by *providing for general state subsidies in taxation of forest lands* intended to benefit localities unable to shoulder the burden alone. This has already been found necessary in Michigan and Pennsylvania.

171. **Taxation of Mature Timber.** — The public will oppose the exemption of mature timber from taxation because it is not in their interest that this should be done. Virgin timber represents taxable wealth, on the same basis as any other tangible property, and no costs of production have been incurred but only those for carrying the property and protecting it. When inaccessible stumpage must be carried for a considerable period before it can be cut, future expenses including prospective taxes serve to depress the stumpage value and consequently the assessed value of the property and may if this valuation is increased prove an excessive burden; but the taxes on stumpage owned by a going or operating concern are paid from operating income.

Again, where an operation, as is usual in lumbering, carries a quantity of mature stumpage sufficient to depreciate the entire investment required to exploit it and this timber is not growing nor increasing in quality due to losses in virgin forests, the tax burden on standing timber is much heavier than a normal burden for a forestry enterprise which is replacing its timber from growth. The required forest capital in the latter case may be less than half as great in quantity and perhaps one third as valuable as that which would be required in the virgin forest to yield the same total cut over a rotation.

The severity of this burden of property taxes has been mitigated in the past by underestimates of the quantity of standing timber and low assessed valuations, though sometimes offset by a high tax rate. Remaining stands of virgin timber will tend to be more and more heavily taxed, relief lying only in cutting. Thus the tendency of the property tax on mature timber is to speed

up its destruction or rapid removal. Farseeing local governments can and do moderate this tax burden, preferring to encourage owners to hold their timber as long as possible so as not to kill the goose that lays the golden egg.

Second-growth timber or timber artificially grown or produced as a crop under forestry methods reaches merchantable sizes or maturity at a comparatively earlier age due to improved markets, the elimination of competing virgin timber and the utilization of smaller sizes. The tax problem for such timber shows the same choice of securing present revenue versus a more abundant future return. Such timber should be taxed when mature, but how, and at what size? If the authorities insist upon placing it on the rolls for annual taxation as soon as it is merchantable for the least valuable product it will yield, which is cordwood or other smaller materials, the individual in turn tends to revise the age of financial maturity downwards and cut the crop sooner, and the resultant net public revenue may be less both from total taxes paid and total benefits received from the use of the timber than if the limit for taxation had been set higher and a more valuable product grown.

172. Property Tax versus Tax at Time of Cutting. — There are two ways of taxing mature timber, a property tax levied annually which is the prevailing system, and a tax on stumpage value when the timber is cut. The total amount of taxes paid on the timber will then depend upon which of these two taxes are levied or in what combination, at what rate, over what period, and on what value. The property tax is the product of assessed value times tax rate over the period elapsing before the timber is cut. The only control which the owner can exercise over his taxes is by advancing the date of cutting, which tends to curtail his ultimate income. A tax on stumpage value on the other hand is paid but once, falls due when the timber is cut and can be met from income received from sale of the timber, hence requires no financing or borrowing. It is often fixed in amount by the terms of the law and *the time of payment is entirely regulated by the owner's control of cutting*, therefore, this tax is freer from risk or uncertainty to him than the property tax.

These stumpage taxes are usually assessed on the quantity cut as measured by a log scale after cutting and as valued on

the stump before cutting. They constitute either a severance or license tax based on the theory of taxing the business of lumbering or removing forest products from the soil, or a so-called yield tax which is in lieu of property taxes that would otherwise have been paid on the standing timber. Severance taxes, which are usually in addition to property taxes on timber, are at a low nominal rate in most cases. The rate of a true yield tax, or the attempt to substitute a tax on income for a tax on property, is more difficult to determine, as it depends on the extent of this substitution..

An attempt to substitute yield and severance taxes for all property taxes on standing timber encounters the obstacle of permitting the individual owner *to determine when he shall pay his taxes or whether he shall pay them at all.* By not cutting his timber he would escape taxation. Thus the owners of private parks or wooded estates would be benefited unduly. To protect public interests the *principle of the annual property tax should be retained,* first, on all virgin timber, next, on second growth timber after it has reached given sizes, which as a measure of sound public economy should not be set too low.

On the other hand, it is equally necessary that a *moderate yield* or combination yield and severance *tax should ultimately be laid on all timber cut,* regardless of size or age or of property taxes previously paid or not paid. Uniformity of application of a yield tax will alone make administration economical and feasible. The yield tax will assure the public of tax revenue from timber which is cut at a size *below the limit of assessment* for property taxes, and from timber which is cut *as soon as the property tax takes effect.* The yield tax should in no case be paid on standing timber, but only when it is cut and yields revenue to meet this tax. The adoption of such a dual system of taxing mature timber will work a hardship only if *the sum of the combined taxes bids fair to be excessive,* and this is the concern *of the public* as well as the owner.

The real purpose of such a dual plan of taxation is as a basic program of tax reform to make possible the removal of any inequality in taxing timberlands as a class (§ 169—2). The restoration of their productivity (§ 169—3) is an additional problem which justifies the consideration of special tax privi-

leges suited to the special conditions that these lands present. Until the necessity for thus taxing mature timber and permitting it to yield its full and equitable share of revenue is conceded no real progress can be made towards this final objective.

173. Taxation of Forest Land Bearing Immature Timber, under the Property Tax. — The question of restoring the productiveness of forest property and bringing it back as a tax producer lies not in the methods of taxing mature timber but in the taxing of forest land bearing young or immature, unmerchantable timber. The property tax is the *only available source of current revenue* from such land. All income from the crop lies in the future out of reach of either owner or tax authorities, but the latter can proceed to levy on the capital values represented by this prospective income, or on the market value of the land, whether this be based on forest production or on any other possible use. The owner must meet these taxes and finance their burden, not from income, but in theory by borrowing or at least by increasing his cash investment (§ 169). To what extent and for how long will he do this and not abandon or relinquish his property to the state in lieu of taxes? If he is forced to this procedure, then not only the owner but the public as well bids fair to be bankrupted unless in turn public funds can be drawn by taxation from other sources, industries and forms of property, and expended under public ownership for the purpose of reëstablishing the productiveness of these lands and ultimately restoring public revenue from timber crops. Such public measures may have to be undertaken on an enormous scale through the failure first of the owner to undertake forest production for economic reasons other than taxation, and second of the public to encourage him to carry this land and keep it productive by adjusting his taxation. *Tax reform is a belated attempt to avoid the indefinite extension of these conditions beyond the capacity of public revenue to finance them.* It is always more costly to rehabilitate a gutted and ruined enterprise than to prevent its getting into this condition.

With a going concern in forestry the only precaution necessary is the general one of preventing the over-taxing of lands of all classes, farm or forest. The forest itself could pay taxes either on income or on property or a combination of both. In either

case the tax revenue is yielded by the property or business as a unit. The tax on timber cut annually or the taxes paid on property carry the land and young timber without accumulating interest or increase in charges. There is a danger of over-valuing property by placing a value on separate parcels and especially on young timber, but as the relation between taxes paid and annual income is demonstrable at all times, over-taxation can be detected and adjusted on such a forest.

Not so on a forest which due to depletion of capital is no longer capable of producing annual income. Most forest properties have already lost the character of a going concern by the exhaustion of their forest capital sometimes to the point of absolute denudation. It is the particular objective of tax reform (§ 169—3) to encourage the restoration of just such properties by removing any handicap that taxation may impose on private efforts to accomplish this slow process.

The property tax on such land, if not modified, will include any accruing values of young timber which may be reflected in the market value of the land and recognized by the assessors. Not only will the sum of all taxes paid during the development or restoration of the forest represent additions to capital investment, but they also represent in fact *advances of tax income* to the public (§ 169) by the owner in exactly the same economic relationship as *between lender and borrower,* the borrower being forced to advance interest to the lender whether he has earned it or not (§ 19). This explains why the "borrower" or landowner defaults when the enterprise no longer justifies such advances. The public have no inherent economic right to such advances, except the right of necessity, which justifies whatever advances the owners can stand without driving them out of the enterprise; but if owners refuse to undertake this enterprise in the first place, the public is put in a most precarious position, and lack of recognition of this situation is an instance of economic blindness fully as culpable as any attaching to the owners themselves in originally wrecking a going concern without considering either their own or the public's permanent benefit.

Whatever reform in legislation is attempted therefore may well be regarded as frankly a remedial or salvage measure in which the public recognizes that whatever taxes it receives henceforth

on denuded or depleted lands is obtained by a partnership with the private owner in the seeking of a mutual benefit, the owner to restore his property to revenue production in order that he may afford ownership, the public that it may continue to derive taxes from this property in order to protect property at large and to maintain the beneficial functions of government.

174. Taxation of Forest Land, Public Considerations. — It will be impossible and probably unnecessary to secure the exemption of the land itself from annual taxation. Land bare of timber or separate from the value of any timber, mature or young, standing or growing upon it, must probably continue to bear an annual property tax as the basis of stabilized town revenues. The problem of determining what taxes land shall pay presents the following considerations:

1. The separation of the value of bare land from that of young timber growing upon it, which otherwise would be considered a part of taxable value of the real estate;
2. The distinction between the value of land for true forest production and its value for other purposes which may greatly increase its market value beyond any possible use value for forest production;
3. Changes in market value of land which may take place during the period of restoration of the forest.

On the part of the public it is necessary to guard against the listing and taxing of land *on the basis of low forest values* whose actual market value for private estates, for agriculture or for suburban property may exceed this value (2), indicating a higher form of use than private forestry. The measures proposed to meet this objection are:

a. Classification by state or local authorities;
b. Upper limitation of values of land which may be so classified, exclusive of timber values;
c. Taxing the land at its market value and permitting subsequent revaluations.

The sanction of local authorities to the listing of lands for forest taxation (*a*) tends to remove later hostility to such classification, though it interposes initial barriers. The placing of an upper

limit of value (*b*) is necessary where lands are to be carried at a fixed value for long periods (3). The process of reassessing land values and basing said valuation on market value at all times, exclusive only of the value of the timber thereon (*c*), is the greatest concession to the public necessity for tax revenues and the least to the owner, but offers the simplest plan of adjustment to changing economic conditions (3), and permits of the *universal adoption of a system of taxing timberlands, irrespective of special classification of land.* In desperate situations it may not produce results in bringing about private forestry practice, while in regions more favorably located it may prove desirable. It is the basis of the Massachusetts forest tax law.

175. **Tax Income Produced by Forests under Different Systems of Taxation.** — From the standpoint of producing income, the comparative results of property tax and yield or stumpage tax may be shown for forests of equal capacity in timber production. The comparative merits of different forms of taxation can best be weighed by judging them on the basis of what a forest established as a going concern could afford to pay. The premise for such a forest is continuous annual income, so it will be assumed that such a forest will yield 1 acre of ripe timber per year. This requires a 50 acre tract for a 50 year crop; e. g. Assume that white pine in pure stands in New England will yield on second quality site an average of 70 per cent of a fully stocked yield. Land is worth $10.00 per acre.

Age Years	Yield board feet	Value of stumpage per thousand Dollars	Value per acre approximately Dollars	Value with land Dollars
30	8750	7.00	60.00	70.00
40	22960	10.00	230.00	240.00
50	32550	15.00	490.00	500.00

Land stocked with young pine is worth:

at 10 years $20.00 per acre,
at 20 years $30.00 per acre.

Taxes will be reckoned on full market value of property, but on a rate of 10 mills only, which is equivalent to 20 mills on ½ value. At 5 per cent for interest, the rate is equivalent to $\frac{.01}{.05} = .20$ or 20 per cent of income.

Neglecting annual expenses other than taxes, the forest value, capitalized at 5 per cent, is $9,800. The income from taxation is,

On capital $9,800.00 × .01 = $98.00 per year.
On income 490.00 × .20 = $98.00 per year, or an average of

$1.96 per acre annually which is the normal tax-producing capacity of the property permanently.

Under the property tax system land is reassessed approximately every 10 years. If this property were separated into tracts of different ages under different owners, the assessed values at the beginning of this 10-year period and the taxes for 10 years would be:

TABLE IV

Total Cash Taxes on 1 Acre For 50 Years

Age of timber Years	Assessed value of land and timber Dollars	Taxes per year at 1 per cent Dollars	Tax revenue for 10 years or on ten acres Dollars
0	10.00	.10	1.00
10	20.00	.20	2.00
20	30.00	.30	3.00
30	70.00	.70	7.00
40	240.00	2.40	24.00
Total tax revenue			37.00

on 1 acre or on 50 acres for 1 year, or on 5 acres for 10 years.

The cash tax revenue by this property tax system as compared with a tax based on income value is but 37¾ per cent of the latter in this instance. This is due to two factors. Taken separately, none of these areas constitute a going concern; and when assessed, no timber has reached 50 years, the oldest lacking 10 years of maturity. Values in growing forests steadily increase, and assessors cannot revalue such property annually, hence even if fully assessed at time of valuation, this increase still escapes taxation during the period. On the other hand, a forest which is producing a steady revenue can in theory be appraised quite easily. The above forest if in one unit and assessed on income would be worth as shown $9,800, while under the property tax its assessed value is but $3,700.

This does not tell the whole story. Each of these owners has

to wait until he harvests his crop before it will yield income to carry his taxes, so whether it be the man who owns nothing but bare soil or the one who has half-grown timber, the taxes are advances by him for public purposes. Reducing future gross income to its equivalent in present taxes, or extending these taxes with interest to the 50th year at 5 per cent, gives the following results, employing the formula:

$$\frac{e}{.0p}(1.0p^a - 1)1.0p^b \qquad (\S\ 181)$$

TABLE V

TOTAL TAXES AND INTEREST ON 1 ACRE FOR 50 YEARS

Year	Annual tax	Tax capitalized $\frac{e}{.0p}$ Dollars	Multiple for 10 years $1.0p^a - 1$	Remaining period years	Multiple for period years $1.0p^b$	Total tax with interest Dollars
0	.10	2.00	.6289	40	7.04	8.85
10	.20	4.00	.6289	30	4.3219	10.87
20	.30	6.00	.6289	20	2.6533	10.01
30	.70	14.00	.6289	10	1.6289	14.34
40	2.70	48.00	.6289	..	.....	30.19
				Sum of taxes with interest		$74.26

which is 75.77 per cent of the cash yield tax of $98.00 paid by a going concern.

Since the equivalent income tax is 20 per cent, the property tax when discounted for advance payments in this case still leaves one-fourth of the income tax or 5 per cent of stumpage value as a margin to encourage the enterprise in its formative stage. This margin does not take account of the outlay required for fire protection and other operating costs, in either case.

This comparison must now be extended to measures for further alleviation intended especially to apply to owners of bare forest land or very young trees. The measure most commonly advocated is the separation of value of land from that of any timber growing upon it, which in practice can be done only by arbitrarily basing the assessed value of such property on that of similar bare land.

Results are shown below where timber is not taxed until cut, and when, instead, it is placed on the property tax list at 40 or at 30 years respectively or entirely exempted. The method of computation is the same as for the above problem.

TABLE VI

COMPARISON OF PROPERTY TAXES ON PINE TIMBER UNDER PARTIAL AND NO EXEMPTIONS

	Property tax Value assessed	Period Years	Taxes paid Dollars	Taxes and interest Dollars	Per cent of yield tax with interest credited	Per cent of stumpage value represented	Margin for yield tax to equal 20 per cent of $98.00
Land	10.00	50	5.00	20.93			
Young growth	10.00	10 + 30	1.00	5.44			
Young growth	20.00	10 + 20	2.00	6.67			
Timber	60.00	10 + 10	6.00	12.29			
Timber	230.00	10	23.00	28.93			
			37.00	74.26	75.77	15.15	4.85
Timber exempted for 30 years							
Land	10.00	50	5.00	20.93			
Timber	60.00	10 + 10	6.00	12.29			
Timber	230.00	10	23.00	28.93			
			34.00	62.15	63.4	12.3	7.7
Timber exempted for 40 years							
Land	10.00	50	5.00	20.93			
Timber	230.00	10	23.00	28.93			
			28.00	49.86	50.1	10.0	10.0
Timber entirely exempted							
Land	10.00	50	5.00	20.93	21.3	4.3	15.7

If taxes are limited to 20 per cent of gross stumpage value, the remaining 80 per cent must constitute the margin for operating expenses and returns to capital. This will in this case suffice.

The above example gives a comparison for a forest investment which earns over 5 per cent compound interest on a comparatively short rotation period. The slower the growth and longer the period required to produce timber crops, the less favorable will the comparison be for the property tax as against income taxes, and the greater the desirability of adopting some modification of this system to encourage reëstablishment of forest production.

E. g. For hardwoods in New England the following illustration is given. Site Class II yields, not reduced from normal.

Age Years	Yield Board feet	Value of stumpage per thousand Dollars	Value per acre approximately Dollars
40	1920	5.00	10.00
50	4780	10.00	47.80
60	8660	15.00	129.90
70	12710	20.00	254.20

Land is valued at $5.00 per acre and 5 per cent discount is the basis of comparison of taxes. The equivalent of a 1 per cent property tax would be 20 per cent of income. At 20 years the valuation is raised to $10.00 per acre. A stumpage tax at 20 per cent yields $50.84 per acre at 70 years.

TABLE VII

COMPARISON OF PROPERTY TAXES ON HARDWOOD TIMBER UNDER PARTIAL AND NO EXEMPTIONS

Property tax	Period Years	Taxes Paid	Taxes and interest	Per cent of yield tax with interest credited	Per cent of stumpage value	Margin for yield tax to equal 20 per cent of $98.00
Land	70	3.50	29.43			
Young timber .	20 + 30	1.00	4.43			
Timber	10 + 20	1.00	3.34			
Timber	10 + 10	4.80	9.83			
Timber	10	13.00	16.35			
		23.30	63.38	124.7	24.9	—4.9
Timber exempted for 50 years						
Land	70	3.50	29.43			
Timber	10 + 10	4.80	9.83			
Timber	10	13.00	16.35			
		21.30	55.81	109.7	21.9	—1.9
Timber exempted for 60 years						
Land	70	3.50	29.43			
Timber	10	13.00	16.35			
		16.50	45.78	90.0	18.0	+2.0
Timber entirely exempted						
Land	70	3.50	29.43	57.8	11.6	+8.4

176. **Comparison of Property Tax and Tax on Income.** — From these examples it appears that the property tax may be a severe burden on mature timber which is held for a long period, but that on young growing timber the taxable value of the timber develops rapidly late in the period. This, with the impossibility of frequent reassessment and difficulty of securing a full value on such assessments tends to cause taxes from this source to fall below the full equivalent that would be secured from an income or stumpage tax. This discrepancy in part compensates the owner for having to pay these taxes in advance of income, the difference being in lieu of interest on such advances.

This condition of approximate equality between the two systems hold good *only so long as land values are low,* and the expenses of establishing and protecting and growing the timber are kept to a very small, almost negligible sum. Otherwise, not only will the taxes paid on such land exceed the equitable proportion, but interest will reach large figures (see interest on land in case 2) and the margin left for entrepreneur's gain on capital after meeting operating costs and interest returns will shrink rapidly.

The problem of the proper rate of interest to use in these comparisons is the same as for determining profits. The allowance for interest in the above problems is neither a cost to the owner nor is it a payment of taxes, but rather it is a discount allowed the owner for theoretical advances, which gives him the equivalent of interest on these advances by reducing his total tax to that extent. It is also evident that by allowing this discount or benefit of interest to go to the owner, the public receives in cash a much smaller sum than the total of taxes and interest, or of cash taxes paid by an income tax (see cash tax in Table VII), but it is received when needed, in the current year.

177. **Reasons for Failure of Property Tax as Inducement to Practice Forest Production.** — As between the property tax and the stumpage tax under normal conditions, the former, although less productive of revenue, has the advantage as to simplicity of administration and the meeting of public needs in a region where few if any forest properties have been put on the basis of a going concern.

On the other hand, the property tax will utterly fail in its present working to give sufficient inducement or guarantee to private capital to persuade them in sufficient numbers to undertake the business of forest production. The reasons are:

1. The possibility of excessive increases in land values not justified by returns but indicated by economic necessity and public expenditures.
2. Increasing rates of taxation on property. This supplements 1.
3. Necessity for heavy expenditures in establishing the forest crop by planting or otherwise, due to loss of opportunity to secure natural reproduction, and to deterioration of site

through worthless competing vegetation. These expenses incurred at the start take a heavy toll in interest.

4. Disproportionate risk of destruction by fire attaching to young trees, as compared with those of mature size. No salvage possible in case of destruction.
5. Inertia of unfamiliarity with a new business and reluctance to undertake it as entrepreneurs because of the postponement of the returns over a period of 50 years or more.

To meet and overcome these objections is a problem in the reduction of apparent risks. Of these the most outstanding has been the danger of fire. This is being rapidly minimized through public coöperation and state and national activity. There remains this tax risk.

178. Possible Concessions or Inducements to Private Owners. — With the public properly safeguarded, the real problem is the character and extent of concessions to the private owner to induce or encourage him to either continue in the business of forest production instead of in the time-worn groove of forest devastation, or more difficult still, to persuade him to undertake rehabilitation of the industry which he has just wrecked because it was in his judgment more profitable to do so than to try to preserve it as a going concern.

The simplest and most effective provision is to separate the value of immature timber from that of soil for purposes of taxation, and to exempt this timber value from the payment of property taxes until it reaches the sizes or degree of maturity determined as the limit of exemption. At that time, as set forth in § 169, it should normally be placed on the property list and be taxed annually with the land; and in lieu of the taxes exempted, it should when cut pay a reasonable yield tax or license tax.

If immature timber is not relieved of taxation in this way, the principle that taxes paid on unproductive forest property are from the owner's situation an advance to the public from future income is totally ignored and the resultant financial prospect is made so discouraging that but few would be found willing to incur the risk involved.

Further concessions will now depend on the extent to which such measures would work a hardship by increasing the tax burden on remaining lands in the town and the urgency of the economic con-

dition whose remedy is sought. It is obvious that if the region is so preponderatingly forest land and has been so thoroughly denuded that agriculture, originally of minor importance, has been crushed by taxes and loss of markets, a condition of bankruptcy exists and a surgical operation is necessary. This usually means state aid. On the other hand, if agricultural values are high and forest lands are well distributed as wood-lots, no great harm may be done by favoring this class of property.

These concessions consist of:

1. Fixing the assessed value of land on the basis of its initial market value, for a definite period, not subject to revaluation. The longer the period the greater the concession. Periods should bear some relation to the time required to bring a forest to the condition of a going concern.
2. Fixing the assessed value of land at a low or a nominal figure during this period. This approaches the principle of exemption of land from taxation and thus tends to be self-limiting, since the more land is listed and the greater the reduction in value permitted the greater the public burden and the need of public sanction and approval of this burden.
3. Fixing the tax rate which will apply to the land during the period. This in effect, when the land value is also fixed, determines the exact amount of taxes to be paid during the period and gives the maximum assurance against the risk of unknown future expense from taxation.
4. Assumption in part or in whole by the state of the payment of taxes on such lands to county and town to support local government and at the same time to relieve the owner of these payments. This is the extreme measure of aid, made necessary by complete local bankruptcy.
5. Ineffectual methods which have been tried are rebates of taxes, and bonuses for planting.

179. General Concessions.—*Exemption of Immature Timber and Substitution of a Yield Tax.* In administering forest tax laws, many difficulties have arisen because of the apparent need to make exceptions of this class of property in order to modify the property tax as applied to it. The power to classify and exempt young timber, or to substitute a yield tax in part, often requires a constitutional amendment, due to the inclusion in state

constitutions of the principle that the same rate shall apply equally to all classes of property falling under the general property tax. The provisions for concessions fall into two classes, those which can be applied generally to all forest property, and those which should apply only to property specifically listed.

The exemptions of young timber below a given size from annual taxation is a measure *capable of general adoption.* It does not serve to reduce the tax income of towns materially, yet offers appreciable moral encouragement to owners during the difficult period of carrying immature stands. California is endeavoring to pass a constitutional amendment securing this objective. This measure should be adopted universally and irrespective of any further concessions to owners.

The adoption of a yield tax on timber cut is already appearing in the form of severance taxes which apply universally, in theory, but in practice are difficult to collect except from large owners. Safeguarded so as not to apply to material cut for domestic use, such a tax can be generally adopted as a corollary of the universal principle of exempting young timber values from taxation. In such case neither of these measures need be made to depend upon either a special classification of lands, the value of lands so classified, or obligatory forestry measures undertaken by owners. So far, no such general legislation has been adopted except the nominal license or yield tax in certain southern states.

180. Special Concessions.—*Contract Relations.* All other state forest tax measures rest on the principle of special concessions coming under points 1-4 as described in § 178 and requiring the owner to list his land in a separate classification and to comply with certain conditions as a prerequisite of acceptance of this listing. This constitutes in effect an agreement or contract between owner and public by which the public is assured that the owner's land will be brought under actual forest production in return for the concessions or guarantees given touching the risk of future taxation. In some states, as Louisiana, an actual contract is signed after the land has been approved for listing by the state forester and by the parish board, under which the value of the land as determined at time of listing is to be maintained during the period of the contract and not increased by reason of the growth of young timber thereon.

The states of Michigan and Pennsylvania have adopted the

plan of paying part of the owner's local taxes provided he will undertake forest production.

The greatest necessity in such laws is simplicity of operation. At best, the requirement for separate listing puts a burden of formality on the owner and sets up a special accounting by the public officials. The tax relief in itself may not prove a sufficient inducement to incur this expense and trouble, especially since under most laws the taxes are only deferred and finally collected as yield taxes; but when owners have been educated by other means to desire to restore the productiveness to waste lands, and have a reasonable confidence that such crops will not be destroyed, the added encouragement of assurances regarding the risk of uncertain future taxes is often the turning point in the decision to undertake forestry.

Such special laws and contracts usually impose on the owner not only the obligation to engage in forest production but to pay a special yield tax separate from any state-wide license or products tax in lieu of the exemption of young timber plus any favors in land valuation. The better and more permanent plan would be to make exemption of young timber universal and impose a reasonable universal yield tax, regardless of special listing, and as a special inducement to owners faced with serious difficulties in reforestation, to then extend special concessions as to the fixing of land values or tax rates, without penalizing them by yield tax burdens not imposed on less provident owners of adjoining lands. The imposition of a yield tax on such owners and not on others creates a serious administrative difficulty. It may be some time, however, before the need for harmonizing such general and special legislation is recognized by states.

181. Computation of Property Taxes. — Taxes are a rental which is averaged for a term of years coinciding with a period of fixed assessed value and is found by multiplying the value by the tax rate. Reassessment sets up a new value. Meanwhile the tax rate may have increased. It is customary however in predicting taxes to assume an average rate for a given crop period.

Cash taxes may be totalled for a forest crop by multiplying the annual tax for each of these periods by the years in the period and adding the totals.

An appraisal of the cost value represented by taxes involves as usual the decision on a rate of interest to be charged or p per

cent. (In determining the rate earned, x, Chapter XII, taxes are treated as are other costs.) The total of taxes and interest for the final year may be obtained by either of two methods of computation. The first consists of totalling the rental at the end of a period of fixed valuation, by the usual formula:

$$\frac{r}{.0p}(1.0p^a - 1) = V_a$$

and then carrying this cost through to the final year, independent of subsequent outlay, by the formula:

$$V_n = V_a(1.0p)^b$$

giving for the final cost value of this portion of the taxes,

$$V_n = \frac{r}{.0p}(1.0p^a - 1)1.0p^b$$

For illustration see § 174.

The tax cost for the second period receives similar treatment, but is carried to the end over a shorter residual period c, giving:

$$V'_n = \frac{r}{.0p}(1.0p^a - 1)1.0p^c$$

the tax cost for the final period is found by the first step:

$$V''_n = \frac{r}{.0p}(1.0p^a - 1)$$

since the annual payments at this rate continue until the last year.

The alternative method of computation consists of carrying the total taxes and interest along from period to period, which has the advantage of showing this total not merely for the final year but for each year of reassessment.

This is accomplished by adding the net increase in the tax rental to r in the quantity $\frac{r}{.0p}$ to read:

$$\frac{r}{.0p}(1.0p)^a + \frac{r' - r}{.0p}$$

which gives the sum to be carried forward. e. g. Sum of taxes at end of first period:

$$\frac{r}{.0p}(1.0p)^a - \frac{r}{.0p}$$

This sum then bears interest for the remainder of the rotation, until the timber is cut. Taxes for next period:

$$\frac{r'}{.0p}(1.0p)^{a'} - \frac{r'}{.0p}.$$

to be carried to end of the rotation at p per cent as before. As long as each sum is continued at interest throughout the remaining period the correct total is attained. Hence, for end of second period, this is:

$$\left[\frac{r}{.0p}(1.0p)^{a} + \frac{r' - r}{.0p}\right] 1.0p^{a'} - \frac{r'}{.0p}$$

which process can be continued by adding $\frac{r''}{.0p}$, etc.

If only the total for the final year is desired, this is obtained by combining the above to

$$\left[\left(\frac{r}{.0p}\,1.0p^{a} + \frac{r' - r}{.0p}\right) 1.0p^{a'} - \frac{r'' - r'}{.0p}\right] 1.0p^{a'} - \frac{r''}{.0p}$$

e. g. In the problem in § 174, the total taxes and interest by periods is:

$$\left[<\left\{\left[\frac{.10}{.05}(1.05)^{10} + \frac{.20 - .10}{.05}\right]1.05^{10} + \frac{.30 - .20}{.05}\right\} 1.05^{10} + \frac{.70 - .30}{.05}> 1.05^{10} + \frac{2.40 - .70}{.05}\right] 1.05^{10}$$

$$[<\{(2.00 \times 1.6289 + 2.00)1.6289 + 2.00\}1.6289 + 8.00>1.6289 + 34.00]1.6289 - 48.00 = \$74.26.$$ See § 174.

CHAPTER XIX

HAZARDS IN FOREST INVESTMENTS

182. Hazards.—*Definition and Classification.* Risk may be defined as the probability or chance of financial loss attached to a business enterprise. Any factor which might in any way affect this risk is termed a hazard. Factors which increase the risk are positive hazards. Those which tend to diminish risk are negative hazards. The sum of the positive and negative elements of hazard must be appraised in order to measure the probable risk in forest investments. E. g., fire is the greatest positive hazard in forestry. But in the case of standing mature southern yellow pine, investors early discovered that the timber was practically immune to fire damage because of the character of its bark, which so-called negative hazard neutralized the fire hazard and made the investment safe.

Hazards may be classed as physical, moral and economic or financial. Physical hazards are those incurred through the operation of the forces of nature such as fire, winds, insects, drought. Moral hazards are defined as those created by man, above what can be generally attributed to physical hazards. This may be due merely to carelessness or may involve malicious motives, such as incendiarism or theft. Economic hazards arise from the operation of the laws governing prices and tending to increase or decrease gross income and costs of production. One of the most serious hazards is that of taxes (Chapter XVII) which partakes in a greater degree of a moral hazard, because, while influenced by economic tendencies, it is largely determined by voluntary acts of legislation.

Negative hazards fall into the same three classes. Certain physical conditions such as topographic features tend to reduce hazards, others to increase them. This is true of climate, soil, forest cover and cultural features such as roads. Measures intended mostly to reduce the physical hazards are grouped under the form of protection. Other measures may be directed against the moral hazard. The results of such activities in diminishing

positive hazards class them as negative elements or hazards in any appraisal of risk. The sum of all hazards both positive and negative gives the probable risk to the enterprise.

In business, hazards are grouped for purposes of insurance into convenient classes. Fire constitutes the major group. Tornado and hail insurance illustrate other groups. Under the fire hazard would be grouped classes of hazard affecting the probability of fire losses, some positive, some negative and some with both elements. Such analysis of hazards is the basis of insurance ratings.

183. The Reduction or Control of Hazards. — Hazards must be summed up for a given class of business enterprise as a whole, such as forestry, and largely determine the extent to which private capital will invest in such enterprise. The effect of a large positive hazard undiminished by reducing or controlling elements is automatically reflected in the demand for unreasonable or impossible rates of earnings on capital so invested. This high basic rate in turn produces low capital values on all such forest property and is reflected in low sale or market values for cutover forest land unsuited to agriculture. This risk is real. Entrepreneurs tempted by high profits to be earned on these low investment costs may play a losing game. The individual, unaided, can seldom succeed in reducing or controlling serious common or widespread hazards, except at prohibitive costs.

To the extent that hazards are controllable the most effective, permanent control must come through coöperative or social efforts, resting on creation of a common viewpoint or goal, and a pooling of expense such as characterizes the vast fields of endeavor in state fire protection with its educational propaganda, its organization and equipment for prevention and suppression and its enforcement of punitive legislation. These state forces are aided materially by semi-public coöperative associations of landowners, which expend large sums in fire patrol and suppression.

The importation of injurious fungi and insects is now guarded against by national quarantine and inspection. State inspection and control of injurious insects and diseases, supplemented by the activities of the national government, seek to prevent future outbreaks similar to that of the chestnut bark disease.

Private owners may be forced by state legislation to take measures to eliminate unusual fire risks caused by their own operations.

Laws making brush or slash burning compulsory, especially along right of ways, are already adopted in several states. Top-lopping is intended for the same purpose.

In addition to these compulsory private measures, owners of forest property must expect to take extra precautions against fire, similar to those adopted by factories and stores to supplement the work of fire departments. Firebreaks may be constructed and maintained for the protection of plantations, and to guard against excessive hazards. The owner and his tenants and employees should be prepared for fire fighting and equipped with the most suitable tools for the purpose.

The ratio of individual to social effort increases with the size of the business unit. Funds expended for such control, by whatever agency, are subject to the law of diminishing returns, each additional outlay effecting a proportionally smaller reduction of loss, until a point is reached where the saving is less than the expenditure made for the purpose. The point of maximum reduction of hazard is that which gives the smallest total of loss plus protection expense, hence the highest net profit.

It is impossible to completely eliminate hazard, first, because by their very nature a certain amount of such losses is bound to occur anyway, and second, because it may be more profitable to take a residual loss than to seek to eliminate it by preventive expense. It is this minimum or residual hazard with which insurance deals. Here again the principle is to substitute a social or coöperative loss for an individual loss. The general residual hazard to an industry from a specific cause such as fire may be kept down to a very low precentage of value or income by preventive efforts, yet its distribution may be such that individual units may suffer seriously or be totally wiped out. This is the case with fire losses. If these losses can be shared in common, the loss to any individual should be no greater than the general percentage of loss plus his share of the cost of conducting the business of insurance. In case of private stock companies, a further item of profit is added to the cost.

Where it is possible to reduce or control hazards and to distribute the residual hazards by these means, the effect is indirectly reflected in a lowering of basic interest relations and a stimulus of the industry by the inrush of capital and a rise in value of property.

Efficient control and reduction of hazards as well as insurance cost depends on the ability to distribute preventive expense and insurance protection in proper proportion to the value involved and the risk of loss. The value may be termed the liability. The hazard is best expressed as a per cent of this value and is the basis of rates or premiums for insurance. That the per cent or rate of hazard is independent of liability is obvious, but total hazard is the product of liability or value and rate. The distribution of control must be based on total hazard.

In forestry, fire hazard is greatest in the initial year of the crop, and steadily decreases until when timber has reached merchantable sizes it frequently becomes negligible even in the event of the killing of the stand. In Norway merchantable timber is not even insured. Meanwhile liability or value as steadily increases. If for any reason timber cannot be marketed readily, a condition of maximum total hazard is created wherever such timber is subjected to conflagration hazard and is apt to be killed over large areas. This calls for maximum effort and greatest insurance, though the rate would still be low. Where timber is marketable, total hazard falls by reason of low rate of hazard, for while liability is large, loss cannot be excessive.

With young stands, liability is small but rate of hazard is proportionally large and sometimes excessive. Effort in forestry should be concentrated on such stands to reduce this hazard, since even with high rate the *total hazard* is not excessive nor cost unreasonable, and upon success here depends the life of the enterprise. Where, as sometimes happens, the rate of hazard on young stands is moderate, as is the fire hazard on longleaf southern pine, a very low cost results.

184. Fire hazards. — Fire is by far the greatest hazard in forest production. The resistance of trees to fire damage depends on the character of the bark, which differs with the species, and on its thickness, which increases with age for all species. Sandy soils in all regions are far more subject to fire than soils which retain moisture. In many localities fires burn annually on such sites. As a consequence, the tree species which inhabit these situations have developed a fire-resistant bark which often renders them immune to the effects of ordinary fires. This immunity is attained at an early age, but seldom covers the period of reproduction or the seedling stage of growth.

On soils and in localities where fires burn only at long intervals, most tree species are very susceptible to injury, and as the fires which do occur on these sites are unusually severe, practically the entire stand may be killed. The younger the stand, the greater the per cent of mortality and consequent proportion of value destroyed.

The fire hazard is largely due to the inflammable character of the forest floor. The entire mass of accumulated litter and humus will burn when dry enough. Most of the undergrowth is also extremely inflammable. Shade thrown by a dense cover reduces the hazard by preventing extreme desiccation and keeping out brush and grass. Of the materials forming the forest floor and undergrowth, grass, when dry, is the most inflammable. Pine needles come next, while hardwood leaves do not cause a serious blaze. Humus or duff, when dry enough to burn, causes a slow and very destructive ground fire, difficult to extinguish. The hazard is reduced by atmospheric moisture. Except on the sandiest soils, belts of heavy rainfall will give rise to rank vegetation. These are regions of slight hazard. Over most of the forest areas in this country droughts occur either annually or at greater intervals, of sufficient severity to create an excessive fire hazard.

Fire hazard is enormously increased by logging, because of the great increase in litter and slash incidental to the operations. As the liability is reduced in like proportion, the temptation to ignore the risk and abandon the attempt to protect the residual forest values is very great. The elements of fire hazard may be grouped as follows:

Climate hazard—all the climatic factors which might in any way affect the possibility of a forest being destroyed by fire. These are rain, snow, lightning, humidity, evaporation, wind, fog, temperature, insolation. Low relative humidity has recently been shown to be the controlling factor in conflagration hazard. This hazard is first, regional; second, seasonal; and third, variable in cycles, which latter variations produce conflagration hazard, which is the greatest drawback known to the forest enterprise and to insurance.

Soil or edaphic hazard refers to those physical hazards of site upon which the forest is growing. The moisture content of litter

and humus is the immediate gauge of hazard, but this depends in turn upon soil moisture as determined by soil texture and topographic features or drainage. Great and permanent differences in hazard are correlated with soils.

Biotic hazard, also termed occupational hazard, refers to the plant life occupying the site, which may be classified according to cover type, age, form, density and the character of undergrowth. Conifers, due largely to greater inflammability of litter and of foliage, present a greater hazard than broadleaf trees. The difference between young and old stands has already been discussed. Dense undergrowth keeps the litter moist except in excessive drought when the hazard is greatly increased by this same condition. Ground cover in certain types may be very inflammable, such as sweet fern.

Topographic hazards refer to the influence of topographic features upon hazard. Flat unbroken plains present the greatest hazard. This is reduced by streams, rock ledges, slopes and ridges or swamps and differs with different exposures.

Cultural or *exposure hazard* refers to all cultural features constructed by man, but separated from any element of moral hazard attached thereto. Farm land is a beneficial or negative hazard, but the clearing of forest land for farms is a hazard of first magnitude. Railroads are usually a serious positive hazard as are logging operations and the presence of towns, mines or other cultural features which increases the probability of fire occurring. Some cultural features such as roads have strong negative as well as positive factors. Inaccessibility is a very serious hazard, accentuated by lightning fires. Roads and trails greatly reduce this hazard, while in turn introducing a hazard through increased use of the forest. This must be minimized by educational means. Such hazards as logging and other enterprises employing labor may be neutralized by the advantage of a supply of labor for fire fighting under agreements. The elimination of carelessness and development of a forest fire conscientiousness offsets hazards arising from cultural exposure.

Protection hazard includes those forms of cultural or exposure hazard which constitute all the forces brought to bear by man to mitigate the destructive positive hazards to which the forest is subject (§ 183).

Moral hazard is the most important fire hazard. It can be divided into incendiary hazard and negligence hazard. In dealing with the latter, education is of first importance, accompanied by provisions for minimizing the hazard, such as providing fireplaces and supervision of tourist camp grounds. Incendiary fires are set from one or two motives, either in an effort to secure some assured benefit such as improvement of the range in grazing, or through malice to do deliberate injury.

Conflagration hazard is serious not only in its threat of widespread destruction but because it renders more difficult the problem of forest fire insurance. Dependent largely on combined climatic and topographic factors it is far more prevalent in some regions than in others, being greatest where climate is neither too wet nor too dry, supporting a hardy dense growth which dries out periodically, as instanced in northern Minnesota, or in regions of heavy annual rainfall alternating with severe summer drouths as in the Inland Empire region of Idaho.

185. Other Hazards.—*Wind.* Wind resistance is greatest with small timber and becomes less with increasing bulk, height and age. The form, distribution and penetration of the roots of different species determine their resistance to wind-throw. Shallow, rocky soils, or those underlaid by hardpan or water, induce windfall. Regions subject to frequent tornadoes present a wind hazard which must be reckoned with in planning the sequence of logging operations. This hazard is excessive only for mature and over-mature timber, and is a serious factor in operations where a portion of the stand is left for a second crop or as seed trees. If all parts of a tract are accessible, wind-thrown timber can be marketed without loss, provided the quantity thrown does not exceed the capacity of the operation as gauged by the length of time the down trees can be left without deterioration.

Insects. Imported insects as, for example, the gypsy moth are far more dangerous to forests than native insects, as they are practically without any natural parasites, necessitating the introduction of these enemies and extensive control measures.

Native insects occasionally develop possibilities of injury, and may destroy great areas of forest. They are finally checked by disease or parasites. Among the worst of these insects are the bark-boring beetles. Defoliating insects like the larch sawfly or

spruce bud worm may kill timber over entire regions. The destruction of native birds explains the increase of certain forms of injurious insects. Woodpeckers are very useful in keeping boring larvae under control.

Fungus diseases. The only conspicuous instance of widespread destruction of an American species due to fungus attack is found in the ravages of the imported disease of the chestnut, *Endothia parasitica,* which is progressively exterminating what was considered the most important commercial eastern hardwood. Great damage is done to the hardwood of all species of trees by fungi which gain entrance through wounds or knots. These fungi do not kill the trees as they have no effect on the living tissue. This damage is greatest in old timber and is not a serious factor in second growth.

Climatic injuries. Excessive drought in rare instances kills many trees of the more susceptible species in exposed regions or localities. Trees unused to swampy conditions are killed by prolonged flooding of the roots.

Minor injuries are caused by breakage in sleet storms or heavy snows, permitting fungi to enter. Reproduction is especially sensitive to frost, drought and excessive moisture, but the young trees soon become hardy.

Injurious fumes. The physical injury caused by fumes is due to human activities. The fumes from copper smelters will sometimes kill timber twenty miles from the location of the smelter.

Trespass. Timber products are frequently stolen, but the theft is easily discovered, and it is not difficult to identify the trespasser. Losses from this source are the result of neglect of the property, and are easily eliminated by proper marking and posting of boundaries, and the employment of a custodian. The expense of such protection is serious for small tracts whose owners reside at considerable distances, but is immaterial for larger holdings. The character of the population and ease with which small quantities of timber can be transported determine the degree of hazard.

Trespass occurs occasionally in connection with logging operations, where only a portion of the stand is to be cut, or where the tract is interspersed among alien holdings. Reputable firms

incur considerable expense in relocating boundaries not only to prevent others from trespassing, but to avoid accidental encroachment on adjoining lands by their own employees.

As long as the public and the landowners themselves remained completely indifferent to young growth and regarded fires on cutover lands as of no consequence, the risk incurred in the business of forest production was prohibitive. One could as well expect to succeed in a mercantile business when thieves, incendiaries and dishonest debtors abounded, and there existed no effective law or public sentiment to check their operations. The first step in establishing the social conditions which are now making forest production possible was the creation of a new public conscience and understanding on the subject of forest property and forest fires. The elimination of theft of national and state timber, the tremendous progress in fire protection in northern states, and the large sums spent in eastern states for suppression of forest insects and diseases, indicate that this constructive work is succeeding. Under proper social conditions, such as have been secured in certain European countries, the element of risk in forest production may become less than that incurred in almost any other form of enterprise. The requirement of a high rate of interest in forestry is merely the expression of this undeveloped state of civilization as touching forest property, and when investors have sufficient guarantee of the adequate control and reduction of these risks, this rate will fall, as evinced by the larger entry of private capital into this form of enterprise.

CHAPTER XX

FOREST FIRE INSURANCE

186. The Characteristics of Insurance. — Insurance is a means of combining and thus averaging the losses from large numbers of variable individual risks, as illustrated by fire losses. It tends to remove uncertainty, thus diminishing the protective investment required, increasing net earnings and attaining greater efficiency through relief from anxiety. By insurance, individual risk is transferred to others. Only the residual risk incapable of control or reduction by protective measures should thus be treated. The less this residual risk, the greater the ease with which insurance can be perfected. The lack of development of forest fire insurance in America is due largely to the incompleteness of these preliminary processes. The only recourse an individual has in guarding against residual non-controllable hazards (§ 183) is to require a liberal margin for profit and risk (§ 154) as the price of his participation in the enterprise, thus establishing costs of production on a higher plane. The average risk for the industry may be, for instance, as low as ⅛th of 1 per cent, but the individual, risking a total loss, cannot accept this average for himself and each one may appraise it at 2 per cent. By pooling these risks, each bearing his true share of the total, or ⅛th of 1 per cent, the cost of insurance is reduced 16 fold and individual loss and uncertainty eliminated. By transferring the non-reducible hazards, insurance establishes forest property as safe security for loans, tends to a more conservative exploitation, and by cheapening costs and reducing the basic rate of interest, stimulates forest production. This in turn will ultimately reduce high taxes by increasing the taxable wealth and will further increase profits and public welfare.

The two objections raised against insurance are high cost of premiums and moral hazard or temptation to destroy the forest for the sake of the insurance. This hazard is inherent in all forms of fire insurance. It is not an argument against the institution itself, but indicates maladministration, curable by proper measures.

187. Forest Insurance Organization. — In order to meet the

requirements above outlined, a forest insurance organization must conform to certain requirements to avoid bankruptcy and furnish a safe risk in the face of possible conflagration losses. It must operate in more than one region, and the wider its field the better. It must be conducted at a minimum operating expense if it is to attract a sufficiently large number of risks. It must be able and willing to accept all the "coverage" or cover all the insurance demanded. It should employ technical assistance in determining values in settlement of claims and in appraising risks.

Insurance may be handled by private stock companies for profit, by coöperative or mutual companies at cost, by public agency, or by the owners directly. Stock companies handling general fire insurance in America possess large resources capable of meeting conflagration losses. This is their greatest advantage. Such policies are nonassessable. Certain of these companies have since 1923 offered insurance on forest property in the United States. In 1918 but one company was in the field and confined its risks to northeastern woodlands and largely to mature timber. Due to the element of profit, the unfamiliarity of American companies with the true cost of this insurance and the undeveloped stage of forestry, premiums required are still so high as to offer a serious obstacle to such insurance for enterprises not on a going basis.

Underwriters whose methods are similar to Lloyd's have not offered insurance so far, though the English Lloyd's insured a large tract of Canadian spruce timber in 1911.

Mutual insurance or coöperative group insurance was introduced February 21, 1917, in New Hampshire by a group of forest owners. By selecting risks to avoid serious hazards this company operated for the first year on 2 per cent, reducing the rate for the succeeding year to 1¾ per cent, and keeping their disbursements to 72 per cent of income in spite of initial costs and small numbers (67 policy holders and $327,192 of insurance, 87.4 per cent of which was in merchantable timber). The company felt that with 3 to 4 million dollars of insurance the rate should not be over 1 per cent. The war interrupted the expansion of this enterprise and its directors in 1918 having demonstrated the possibility of such organization transferred the risks to a stock company.

The advantages of mutual companies are in theory that policy

holders obtain their insurance at cost, which includes losses plus administrative expense but no element of profit. Where such insurance is undertaken by a coöperative group its field is usually restricted as in the New Hampshire example, and confined to risks of a similar character, thus reducing administrative cost, moral hazard and excessive physical hazard. Very little reserve is provided for, insurance being at cost from year to year with rebates in good years and assessments in poor years. Conflagration losses could seldom be met in full.

Any attempt to form a mutual company for exclusive forest insurance, large enough to avoid conflagration hazard by wide dispersal of risks, would in turn incur the danger of inefficient administration through loss of close supervision by policy holders. Mutual companies doing a general insurance business suffer from this same drawback. Such companies, if efficiency is secured, are in position to undertake and carry forest insurance at less cost than stock companies.

Government or state forest insurance is nowhere in force and while possessing the theoretical merit of low cost by complete distribution of risks, would be apt to break down through lack of efficiency and moral risk, in the present stage of our forestry progress.

For a considerable period most of the forest properties will probably be carried without outside insurance, the owner assuming his own residual risk. This will be due largely to the cost of insurance in stock companies, 45 per cent of whose premiums are required to meet administrative costs. For large properties, if these were distributed over more than one region, such self-insurance might suffice. But with a few exceptions, the reverse is true, and holdings are concentrated in a single block or region and are subject to the same conflagration hazard. This hazard is therefore the most serious detriment to self-insurance against fire loss as it is to small local coöperative insurance. It should be emphasized that conflagration hazard is controllable by the same means in forest areas as it is in cities; efficient organizations and prompt action in suppressing all fires which start. Conflagrations, once common in the west, are now held in check over practically all the western forest areas, and with the attainment of an equal degree of efficiency this should hold true of any region.

The need in forest insurance is for statistics which will show

the burning rate or loss per year in actual value, from fires. Records should cover at least twenty years to give reliable averages. Existing records everywhere fail to give such reliable data on value as a whole. Area burned is only approximately correct and values still less accurate. The records fail to furnish any basis for distinguishing hazards, separating and valuing loss to young timber or on different classes of timber.

Since in many instances local fire wardens must collect this data, the obstacles to accurate detail will remain in force. Improvements may be made by securing appraisal of large fires by technical examiners and by requiring accurate area reports of all fires rather than statistical reports on damage. Such statistics are used as are available, as one element in rate-making. Present conditions, the general experience of companies in similar lines, and finally, personal judgment of underwriters form the basis of this appraisal of rates. As in all other appraisals, past experience as expressed by statistics is of great value but will never overtake present conditions due to constant dynamic changes. The need for statistics and the form in which they will be needed is never foreseen long enough ahead. Incomplete statistics are comparatively valueless, and when in proper form their value is in direct ratio to the length of time over which this record has been kept. Detailed statistics when covering large areas are expensive and require trained personnel for accuracy, on which their reliability depends.

Future effort should be concentrated on physical data on the character of the damage, covering site, density of stand, species, average diameter, number or per cent of trees killed or damaged, elapsed time in reaching fire or such items as can be easily determined by the warden. No effort should be made to secure appraisals of the value of damage from warden reports. These should be determined by a forest actuary on the basis of the reports submitted, and classified by regions, types, age groups, causes and other factors necessary for the rating of hazards in terms of *value* destroyed. In Finland where excellent statistics exist, the fire risk has been expressed as the risk of kindling, or number of fires starting; the risk of spread, or area per fire; and the risk of burning, or per cent of the total forest area burned annually.

188. Insurance Rates and Rating. — Insurance rates are a given per cent of the sum for which the property is insured. This insured value multiplied by the rate gives the premium. Premiums

TABLE VIII

FOREST INSURANCE SCHEDULE OF RATES FOR THE STATE OF MICHIGAN.
COMMERCIAL COMPANIES

	Plus	Minus
Basic charge per $100 of insurance	$0.75	.....
Exposure hazard on property or directly adjacent		
Railway right-of-way	.40	.....
Coal burning	.20	.....
Spark arresters	.....	0-.15
Patrol system	.....	0-.10
Fire lines	.....	0-.10
Railroad fire fighting force	.....	0-.10
Right-of-way clean	.....	0-.05
Motorized highway	.10-.30	.....
Right-of-way	.....	0-.05
Fire line	.....	0-.10
Wagon road or trail		
Right-of-way clean	.....	0-.05
Summer resort or camp ground	.0-.25	.....
Fire protective system	.....	0-.15
Logging	0-.15	.....
Coal burning machinery	.10	.....
Spark arresters	.....	.07
Fire protective system	.....	0-.15
Other industrial establishments	0-.40	.....
Fire protective system	.....	0-.40
Farms	0-.40	.....
Land clearing going on	.10-.20	.....
Exposure hazard within two miles of property		
Railroad right-of-way	.20	.....
Coal burning	.10	.....
Spark arresters	.....	0-.08
Patrol system	.....	0-.05
Fire lines	.....	0-.05
Railroad fire fighting force	.....	0-.05
Right-of-way clean	.....	0-.03
Motorized highway	.05-.15	.....
Right-of-way clean	.....	0-.03
Fire lines	.....	0-.05
Wagon road or trail		
Right-of-way clean	.....	0-.03
Summer resort or camp ground	0-.15	.....
Fire protective system	.....	.....
Logging	0-.10	.....
Coal burning machinery	.05	.....
Spark arresters	.....	.04
Fire protective system	.....	0-.10
Other industrial establishments	0-.20	.....
Fire protective systems	.....	0-.20
Farms	0-.20	.....
Land clearing going on	.05-.10	.....
Towns of under 500 inhabitants within two miles of property	.10-.20	.....
Increase charge in direct proportion to population and decrease charge inversely with greater distance up to 50 miles Maximum charge, $0.50		

TABLE VIII (Continued)

	Plus	Minus
Slash		
If property or property directly adjacent has been logged within 10 years without adequate brush disposal	.15-.30	.....
Protected by fire line	.....	0-.15
If within two miles of such property	.07-.15	.....
Protected by fire line	.....	0-.10
Sport		
Fishable water on or within ¼ mile of property	.10-.20	.....
Fishable water within 2 miles of property	0-.10	.....
Land posted with warnings	0-.05	.....
Blueberry land		
On property or directly adjacent	.10-.20	.....
Within 2 miles of property	.05-.10	.....
Nature of stand		
Plantations and young growth under 25 years of age	.....	.....
Conifers	.40	.....
Broadleaf	.10	.....
Pure (90%) conifers over 25 years	.15	.....
Swamp type	.....	.10
Protection		
System of detection and suppression	.....	.10-.40
System of prevention fire lines	.....	0-.25

are determined from rating schedules, consisting of a basic charge to which additions or subtractions are made for differences in positive or negative hazards (§ 182). The economic objective of rating is to equalize the rates and hazards on all the risks insured. This equilibrium is impossible of attainment because of the lack of a basis for determining facts as to the true or actual percentages of loss due to each combination of hazards involved. Not only are reliable classified statistics lacking for a period sufficient for a base, but hazards are constantly changing. Rates, in all lines of insurance, are made by the principle of appraisals for such ratings, and must continue to be based on such appraisals.

An example of ratings for forest insurance is given above. This was prepared for northern Michigan by Prof. Paul A. Herbert, Michigan Agricultural College, East Lansing. A somewhat similar schedule was adopted as the basis for such insurance by an eastern stock company.

189. Evaluation of Insurance Losses. — In placing a value upon property to be insured the responsibility rests with the owner, since the expense of appraisal for this purpose by the company

would be prohibitive. The company is protected, first, by requiring a report from the owner, covering all conditions affecting hazards before issuing the policy (§ 191); second, by proper classification of the risk and proper rating (§188); third, by determinations or adjustment of true value of such loss as occurs, through expert appraisal; fourth, by adopting conservative and safe principles of ascertaining this true insurance value (§ 189); fifth, by requiring a co-insurance clause in the policy. This protection of the company is fundamental if insurance is to perform the social function for which it is intended, otherwise the moral hazard of over-insurance will tend to wreck the enterprise and undermine public confidence.

Co-insurance is a clause which makes the owner of the property a party to any insurance placed on the property, to the amount of the difference between the true value and the insured value. Under this clause, forest property insured for half its true value will, if partially damaged, receive an adjustment of half the value of the loss, the co-insurer or owner bearing the other half. In no case can the owner receive more than the true value as determined by the principles prescribed in the policy and by the accepted practice of valuation and he receives the full value only when the insured value, i. e. the standing timber, is totally destroyed. If the owner over-values his property and carries excessive insurance, he loses the excess of premiums paid instead of profiting at public expense through over-payment of losses. True value cannot be determined by the company until loss occurs, hence the owner is the responsible party in over-valuation. Co-insurance is practically universal in Europe, but in America is widely misunderstood, the idea being that a loss equal to the insured value must be paid in full regardless of the fact that insurance was carried and premiums paid on only half of the true value; and that the over-insurance should be paid in case of total loss, even if this loss does not equal the insured value. Such ideas are anti-social.

The basis of value on which adjustment will be made should be clearly set forth so that the owner can be governed accordingly in his application. Face value of a policy is simply the maximum loss for which the company can be held liable. Actual value before and after the fire must be determined by the adjuster.

The most important principle which distinguishes insurance from damages is that damages are based on a loss to the individual

for which the full loss in value to him is a true measure to be required of the responsible party, while insurance undertakes only to adjust loss of value which is fully established on a social basis, or as a market value. Where true value still exceeds market value, this excess represents a margin not properly insurable, for to do so would enable the owner to collect value from society through loss by fire which he would not obtain by ordinary sale. Forest insurance valuation, as long as insurance remains on the voluntary basis, cannot rise above sale or market value in principle without endangering the enterprise.

On this basis, stands which have reached ages having a merchantable value, which is usually at 6 to 8 inches, should be insured for this present value and not on the basis of their expectation value for a future date when they reach larger sizes, though such value may exceed sale value at present. Young stands which have not yet reached merchantable sizes present the greatest difficulty in insurance. For such stands sale or market value is frequently much below true value (§ 101) and the determination of the latter is difficult, even when correct appraisal methods are used (§§ 94 and 122). In European countries, notably Norway, Sweden, Finland, Germany, France, Denmark and Holland, where forest values rest on generally accepted practice and forest insurance is in force, the sale value of lands bearing immature timber coincides so closely with the true value that the former can be and is accepted as the basis of insurance down to an age approximating one third of the rotation or age of maturity. Below this age, even in these countries, it is considered necessary to substitute the cost of replacement (§ 117). This cost of replacement is obtained by taking average costs of planting, setting a maximum figure, and carrying this cost plus taxes and administrative charges at a given or fixed rate of compound interest to the age of the crop when destroyed. Interest on the value of the land is included. The interest rate is standardized in the policy and derived from the average rate earned by these investments as nearly as can be ascertained. For less than normal stocking, discounts are made from this value. This cost of planting is included even when stands are reproduced naturally, thus actually compensating for loss in value due to the necessity for replanting (§ 129) because of the fire.

In America the extension of insurance to cover immature or

unmerchantable timber will not be possible unless this same general plan is followed. Replacement or cost value is the only practicable basis for valuing plantations or very young timber, but for general acceptance, the conservative basis will be the cost of replacing stands by natural seeding rather than the cost of planting. Such cost value would then be confined to taxes, protective and administrative costs with interest compounded at a fixed per cent to the actual average age of the stand less a percentage deduction for subnormal density of stocking. Interest on value of land can safely be included. This basis rests on the presumption that plantations are actually worth no more than natural stands at present provided they compare in density. As a matter of fact, plantations exceed the value of natural stands whenever more perfect stocking is secured, or the quality of the site has been improved by previous clearing and cultivation. Companies could safely insure plantations at actual average costs of planting for a region. There is no serious moral hazard involved in compensating persons of the sort who expend funds for reforestation in this manner, by returning the actual outlay. As the stands grow in age, the question of interest on this cost, plus the annual expenses, plus interest on land, and the rate of interest to employ, does create a possibility of over-valuation (§ 89). To guard against this, one stock company insures only to 80 per cent of replacement costs. The best precaution is a low rate of interest.

For timber over one third of the rotation age, sale value, i. e., the value of such timber as determined by sales of property minus such value as represents bare land, should be ascertained for several regions and form the basis of adjustment. With the recognition of true value by sales, insurance values can be revised upwards to keep pace. As long as low sale values continue for young timber there will be an equally low value for true forest land, and the curve of value for such age classes will sag even more than indicated in Fig. XII, page 169, since it will be based more largely on the maturing of merchantable value than on expectation value.

190. Adjustment of Loss. — An adjustment consists in reaching an agreement with the insured party as to the amount of the claim for which the insurer is liable under the policy contract, or, on failure to reach such an agreement, to obtain a

settlement through the means prescribed in such cases. This may be either an umpire or court proceedings. If the value of the policy appears adequate to the examiner and the loss is total, no difficulty presents itself in adjustment.

In case it appears necessary to appraise the loss, the first step in adjustment is to determine the character and extent of the physical loss. The methods for determining this loss are described in § 119. In case of total destruction of value as when stands of unmerchantable timber are killed, the problem is comparatively simple. When only partial damage occurs, examination should always be postponed until the effects of the fire become fully evident. Fall fires should not be appraised until the following summer, and spring fires not until late in the year. Examination of broadleaf species should always be made when the trees are in foliage and never in winter or under snow. Policies should therefore permit adjustment to be made any time within one year. The loss must be confined to that directly due to the fire, including fire fighting, i.e. necessary backfires or destruction intended to control the fire. Secondary losses may later result from fire, such as insect attacks or the rapid increase of fungus diseases, but these presumptive losses are capable of control and subject to salvage, and a fire insurance policy does not contemplate insuring against them.

In America the loss will usually be restricted to the standing timber and will exclude damage to the leaf litter or humus, damage to the root stocks, or deterioration in quality of the new crop and loss by reason of disarrangement of management, for the reason that the standards for measuring such losses have not yet become socially established and they cannot safely be admitted in insurance practice until this has taken place.

Maximum values for timber of different ages and character are usually made a part of the policy. In any case the actual liability is not the face of the policy unless it is known that the value was fully insured and totally destroyed (§ 186). The value of the loss will be appraised by standard methods based on the principle of sale value (§ 189). For merchantable timber, salvage value will be determined, and if damage is partial, will depend as usual on whether only the damaged trees should be removed or the entire stand.

Most European Mutual Associations provide for the appoint-

ment of an examiner by both parties, who may agree upon a third, the decision of the latter to be final in case his services are needed.

191. Insurance Costs. — The total cost of insurance will depend first upon the extent to which hazards have been reduced by the combined efforts of the public and the owner, and the estimated resultant margin of unavoidable risk which must be covered; second, upon the closeness with which the cost of insurance can be held to the amount of this actual risk, combining financial security of the company with reduction of profit and administrative costs; third, upon whether the expense must run at compound interest until the maturity of the timber or can be carried as a current expense by a going concern.

It is evident that the greatest hazard and consequent highest rates and most beneficial operation of insurance falls on immature timber and that the security offered at this stage of development of the forest enterprise will result in greatest social benefit and stimulus to forestry. Low insurable values, both intrinsically and due to the need for adhering to market value, will keep down the premiums on such property, and with increasing age and size the rates will be reduced as insurable value increases.

While it is difficult to generalize, yet the annual cost of insurance should tend to remain roughly constant throughout the life of a stand due to these compensating factors. E. g., in the values and rates quoted by the Forest Owner's Mutual Insurance Society of France for pine stands, the cost actually diminishes, as shown below:

TABLE IX

RATES QUOTED BY FOREST OWNERS' MUTUAL INSURANCE SOCIETY OF FRANCE

Age of stand years	Value insurable per acre dollars	Premium rate per cent	Average annual cost per acre dollars
6-10	12.00- 20.00	2.55	.40
11-15	21.00- 28.00	1.40	.345
16-25	29.00- 49.00	.575	.225
26-35	50.00- 65.00	.32	.185
36-40	66.00- 81.00	.27	.20
41 and over	82.00-162.00	.087	.105

The rates suggested by the General Syndicate of French Fixed Premium Fire Insurance Companies are lower than the above for young timber.

TABLE X

RATES QUOTED BY GENERAL SYNDICATE OF FRENCH FIXED PREMIUM FIRE INSURANCE COMPANIES

Age—years	Rate—per cent
1-10	1.0
10-15	.5
15-30	.35
30-50	.25
Over 50	.10

The Gladbacher Fire Insurance Company of Munich, Bavaria, a stock company, graduates its premiums on the following rates for conifers:

TABLE XI

RATES QUOTED BY THE GLADBACHER FIRE INSURANCE COMPANY OF MUNICH, BAVARIA

Age—years	Premium rate per cent
1-10	.32
10-20	.28
20-30	.22
30-40	.15
40-50	.11
50-60	.8
Over 60	.4

The cost of forest insurance in Norway, where none but immature timber is insured, is .12½ per cent where forest fire regulations are in force and .17½ per cent elsewhere. These are mutual rates, and after 8 years these rates are lowered to .06 and .10 per cent respectively; with an average rate in force of .098 in 1921, and expense rates of .042 per cent.

In Finland the rates quoted by the Sampo Mutual Insurance Company are, for young or inferior forests, .15 to .265 per cent, and mature forests, .08 to .165 per cent. The rates quoted by the Swedish Veritas Stock Company for conifers are:

TABLE XII

RATES QUOTED BY THE SWEDISH VERITAS STOCK COMPANY

	Per cent
Plantations under 15 years	.3
Pole forests under 8 inches in diameter	.2
Timber forests over 8 inches	.05
Mixed stands	.15
Hardwoods	.075

These various rates represent established conditions and a minimum of insurance cost. The rates quoted by those American companies offering insurance are considerably higher due to the absence of mutual insurance and to unsettled conditions. These run from a maximum of 3.15 per cent annually, for risks involving immature stands, to a minimum of .5 on mature hardwoods and .75 on mature pine.

Forest insurance, with compound interest, permits of a definite summary of probable future costs with relation to expected yields or profits. It has been estimated that a cost for this purpose should not total, with interest, more than 4 per cent of the final crop value, but present insurance except in certain portions of Europe will exceed this figure, coming closer to 8 or 10 per cent. Entrepreneurs who appraise possible profit without due allowance for fire and other losses are of course making unreliable estimates of profit. The availability of insurance permits of far closer calculations. Insurance may be considered one of the most useful social devices for the protection and stimulus of private forestry.

APPENDIX A

PROBLEMS IN FOREST FINANCE

The results indicated in appraisals of values and determination of rates earned by investments in forestry depend primarily upon quantitative facts which must first be ascertained. Cost is a matter of record and experience; income is gauged as well from past experience and in forestry is based on possible yields. Market prices for forest products, taxes, fire protection and every item of cost or income must be taken from existing conditions if the use of these factors is to give the appraiser any information of value.

For this reason no attempt has been made to assign values to the various quantities which are required in the solution of typical problems. The utility of such solutions by students is to learn the method of handling the formulae of compound interest primarily. This can be done with any assumed values. It is better for the instructor to supply the quantitative basis of the problem from local information. Any values which might be assigned in the text would soon become obsolete even for the limited region and conditions to which they might at the time apply. The method adopted therefore has been merely to state each typical problem with the elements required for its solution.

(§ 86) 1. Cost value of forest property at end of one year for a forest producing a given income. Items, purchase price of the property, in which value of timber and land can be either separated or not; cost of reëstablishment normally incurred during the year including slash disposal, planting, cleaning or weeding; costs of maintenance including fire protection, taxes, supervision, upkeep; income for year from major cuttings, thinnings and minor operations; rate of interest demanded as basis of appraisal.

Determine,

a—total cash cost including I, C and ee.
b—cost value, with interest at p per cent.
c—cash profit P.
d—enterpreneur's gain G.

This problem applies to the results for any year regardless of whether the forest is on a sustained yield or not. The problem can

be applied to a forest managed on the principle of selection, in which an annual cost and income is incurred on each acre or tract.

(§ 87) 2. Cost value at the end of a period of years n for a forest producing no income during the period, but incurring annual expenses for additional crop establishment, and for maintenance. Items, purchase price or initial value of the property; annual cost for additional planting; annual expenses as in problem 1; rate p.

Determine,

a—cash investment at end of period n.

b—cost value in same year.

Employ different annual costs and note the effect on capitalized value of annual expenses $\frac{ee}{.0p}$ and upon cost value.

(§ 88) 3. Cost value of speculative timber holdings or single stands, held for a period of n years. Items, purchase price of the forest tract, or prorated portion of price of a larger purchase; annual expenses as for problem 1 except that usually no cost of reëstablishment is incurred; yield of products at different periods, estimated; rate p.

Determine,

a—cost value of tract for different periods at same rate, and for different rates.

b—cost value per unit of product under the above conditions.

The purpose of making two or more appraisals with different values of p is to demonstrate that cost values, as distinguished from true costs, are merely personal estimates as to the rate of return which is expected on invested capital and what income this would require.

The problem will also apply to a forest cut periodically, and will determine the cost value previous to a cut, based on cost of purchase, or its cost value just subsequent to a cut, prolonged with carrying charges and interest until the end of the period as in problem 2.

(§ 89) 4. Cost value of producing an even-aged crop of timber to an age of n years. Items, cost of land; cost of crop establishment including slash disposal, planting or seed trees; annual expenses; rate p; yield of products at different ages.

Determine,

a—cost value of investment as a whole which would be the sale value required to earn p per cent.

b—cost value of the product or timber which is that of the property minus the credits other than timber (e. g. land).

c—cost value per unit of product.

d—above values for different rates p; for different ages of crop; and for different prices of land.

e—relative effect of increased annual expense and those for crop establishment. Develop the idea of capitalized annual expense as a trust fund not expended hence credited back at end.

5. Cost value of an even-aged crop including incidental items of cost and income, such as cleaning or weeding, and thinnings. Items, same as for problem 4, plus cleaning or weeding; one or more thinnings.

Determine,

a—cost value of property with these additional items of positive cost and negative cost or income and compare with problem 4.

b—cost value of the product or timber.

c—cost value per unit of product.

d—the increasing cost value of the crop at different ages on the same basis of costs but with different rates of appraised interest return, p.

Capital Values.

(§ 91) 6. Capital or expectation value (use value) of a "normal" forest with continuous and non-fluctuating income obtained from successive cuttings which do not exceed productive capacity or growth. Items, value of annual cut from final crop; net value of annual thinnings or their net cost; cost of establishment and tending the crop (cleanings or weedings); total annual expense for production, taxes, supervision, maintenance or other items; rate of interest p.

Determine,

a—the use value, termed capital value of the net income by the formula for capitalizing annual rentals.

b—the value for different rates of interest p, and compare, to show effect of rate on value.

c—alter, by increase or reduction of items of income or of expense, the net annual income and compare capital value at same rate p.

(§ 92) 7. Capital value of a forest being denuded by lumbering operations which will be completed in n years. Items, annual cut, probably in excess of a continuous yield; annual expenses, probably confined to taxes; rate of interest.

Determine,

a—capitalized value as a terminating rental. Compare with sustained yield for same forest.

b—compare the values of problems 6 and 7, solved with different rates to show that high rates of interest indicate a policy of rapid withdrawal of forest capital and low rates encourage the conservation of the forest.

(§ 93) 8. Capital value of a single stand of timber which will be cut n years in the future, and the land sold. Items, final value of yield when cut; sale value of the land at that time; future annual expenses including taxes; rate p.

Determine,

a—present capital value (discounted net value) of the property, including land, for different periods, and for different rates p.

9. Capital value of forest property comprising land and timber, managed on a sustained cut at intervals of a few years m. Items, value of the periodic cut; cost of slash disposal or other costs of establishment or maintenance of productiveness; annual expenses; rate p.

Determine,

a—the capital value of the property without attempt to separate land and timber values, for the year just after cutting.

b—its value just preceding a cut.

(§ 94) 10. Capital value of forest property comprising land and timber for any year a falling between successive cuttings. Items, identical with problem 9.

Determine,

a—value for different years and note gradual approach to final value of property just before cutting.

Note that a change in rate of interest depresses the total value of the property including land for any year including the final year, but does not affect value of the timber which is ready to cut, since this is the income which is assumed, for the problem, as of a given value.

11. Capital value of land bearing an even-aged stand of timber, for any year *a* during its growth. Items, periodic yield from cutting successive crops of timber; periodic cost of reëstablishing a new crop; annual expenses capitalized on a permanent basis; rate *p*.

Determine,

a—for any year *a* the capital value of the property. Compute for different years.

b—effect of annual expenses on value, and its diminishing importance as a cutting is approached.

12. Capital value of land bearing even-aged stands of timber under intensive cultivation. Additional items, cleaning or weeding; thinnings.

Determine,

a—effect of thinnings on value when a given thinning is yet to be made, and after this thinning has been made.

b—effect of a cleaning on value before it has been made, and afterwards. When the date of valuation falls after any item has occurred, when and how does this item influence capital value?

(§ 95) 13. Capital value of bare forest soil. Items, value of periodic crop of timber; periodic cost of reëstablishment; capitalized perpetual expenses; rate *p*.

Determine,

a—value of land for different rates of interest.

b—for different rotations or crop periods with corresponding values for timber crops.

c—for different capitalized expenses.

d—how great an increase in the value of the crop is required to justify a given increase in annual cost of fire protection; in planting costs.

e—what does it signify when capital value of land becomes zero or less?

14. Capital value of bare forest soil growing timber crops under intensive cultivation. Additional items, cost of cleaning or weeding; income from thinnings.

Determine,

a—the effect of early versus late thinnings on soil value.

b—the effect of weedings, assuming no increase in income, and assuming an increase more than sufficient to return the expense.

Rate earned by forest investments.

(§ 105) 15. Rate earned annually on a forest managed under a sustained annual yield and income. Items, purchase price or appraised cost of forest; working capital required for one year's expense; annual income from final cuttings; incidental income from thinnings or other sources.

Determine,

a—the rate x earned annually.

b—the difference in rate earned caused by increasing the cost or investment value.

(§ 106) 16. Rate earned over periods of deferred returns, based on compound interest. Items, initial investment in a timber tract; final sale value after n years. Omit in this preliminary problem all carrying charges.

Determine,

a—the rate of compound interest x earned.

b—the difference in this rate caused by increase in income or sale value, and increase or decrease in cost of purchase.

17. Rate earned on initial investments in timber tracts, regarding working capital as borrowed at a standard rate p per cent and as covering current annual expense only. Items, cost of land and timber (there will be no additional cost of establish-

ment); annual expenses including taxes; rate p on this borrowed capital (observe that the capitalized expense $\frac{e}{.0p}$ can be borrowed and returned intact at end of period).

Determine,

a—rate x earned.

b—note whether this rate exceeds p. If so or if it is less than p, what effect has borrowing this sum upon the rate earned by the remaining investment.

c—solve this problem by the Pressler formula, first determining the working capital as E.

(§ 108) 18. Rate earned on total invested capital including all working capital represented by annual expenses. Items, cost of land and timber; annual expenses; sale value of property including timber and land.

Determine,

a—the rate x earned, by trial. Work out one example until the final rate is obtained within 1/10th of 1 per cent.

19. Adapt problem 18 to a plantation, substituting cost of establishment for initial cost of timber.

20. Rate earned by a plantation including all items of cost and income, by method of trial and error. Items, investment in land; cost of reëstablishment as planting; cost of weeding or cleaning in a given year; annual expenses including taxes; final yield; intermediate yield from thinnings at given years.

Determine,

a—rate x earned.

b—difference in rate caused by taxes, by early thinnings, and by cleanings.

c—compare rate for plantations on old field where no cleanings are required with that for cutover land which requires cleaning.

(§ 109) 21. For the values given in problem 20, to determine the rate earned by means of plotting the curve of mean annual forest per cent. Items, same as for problem 20.

Determine,

a—capital value of soil for different per cents p, differing by ½ per cent.

b—the rate earned by any given investment or cost of land by reading from curve of values plotted from *a*.

22. Constructing an indicator graph. Items, average cost and income for a locally important species.

Determine,

a—the rate earned for each of several successive rotations.

b—make a curve for each rotation showing rate earned by different soil costs.

c—plot the points giving the same rate above the rotation age and opposite the required land value and connect by a curve.

d—do this for each per cent, thus constructing an Indicator Graph of Mean Annual Forest Per Cent for different costs of land, and different rotations.

(§ 110) 23. Appraisal of value of young timber based on capital value employing the rate earned x. Items, final yield; incidental yields from future thinnings; expenses intervening before yield is obtained; value of soil; year a in which value is sought; rate x earned by this investment which must either be known or determined by knowing also all costs and income as in examples 20 or 21.

Determine,

a—value of property for year *a*.

b—by subtracting value of land, separate the value of the standing timber.

24. Appraisal of young timber based on cost value, employing the rate earned x. Items, cost of land; cost of planting or establishment; of weeding; annual expenses, up to year of valuation a; rate earned, x.

Determine,

a—cost value for same year as capital value in problem 23 and note difference.

b—what does this difference signify and how could it be corrected.

The above problem may be outlined first by omitting incidental costs (weeding), or income (thinnings).

Entrepreneur's gain.

(§ 111) 25. Method of indicating entrepreneur's gain. Comparison of rate earned and basic rate of interest, p, for one of the above problems 21 or 22. Items, data from problems; rate p which applies to the problem.

Determine, for the same rotation,

a—the comparison between rate earned x and basic rate p.

b—comparison between rate earned x and a rate of 1 per cent compound interest.

c—the comparison between $x - p$ per cent and 1 per cent compound interest.

d—the rate of simple interest which the rate x represents, by determining first the total per cent earned and dividing this per cent by the years in the period.

26. Comparison of cost value with capital value as a means of indicating entrepreneur's gain for any year a. Items, all costs; all items of income for a crop of timber or any forest investment, covering a given period; rate p, the basic rate of interest for the investment.

Determine,

a—cost value to year a, at p per cent.

b—capital value from final year n to year a, at p per cent.

c—entrepreneur's gain, as the difference between these two values.

27. Entrepreneur's gain in final year. Items, final income, plus sale value of land; total net cost value crediting incidental income from thinnings.

Determine,

a—resultant margin of gain over cost value.

28. Entrepreneur's gain in initial year expressed in terms of soil values. Items, values in problem 26; soil capital values; rate p.

Determine,

a—entrepreneur's gain by comparing soil values with soil cost.

29. The equation of entrepreneur's gain. Items, entrepreneur's gain in final year; in initial year; in any intermediate year *a;* from problem 26 to 28.

Determine,

a—the comparative value of the gain in problem 26 to 28 when reduced to the same year by interest or discount.

b—form the equation of entrepreneur's gain.

c—show how by shifting the time forward or back over a given period, items of cost or income occurring within that period are transferred from cost value to capital value or vice versa, with signs reversed, and how the same element of entrepreneur's gain always serves to balance this equation.

(§ 120) 30. Effect of soil value upon the appraised value of young timber. Items, final income; cost of reëstablishment; annual expenses.

Determine,

a— for each of two different soil values the rate earned by the investment.

b—by using the separate rates, the appraised value of the young timber at one half the age of the final crop, by capital value appraisal.

c—ditto by cost value appraisal. Compare values *b* and *c*. Explain difference.

Damages.

(§ 124) 31. Damage to merchantable timber. Items, stumpage value of entire tract of timber before the fire; quantity of timber destroyed or injured; increased cost of logging undamaged timber.

Determine,

a—loss in value of quantity damaged.

b—loss in value of remainder of tract.

(§ 125) 32. Damage to timber which cannot be logged immediately. Items, quantity of timber lost or damaged; price of stumpage.

Determine,

a—present stumpage value before damage.

b—present stumpage value after damage disregarding future expenses.

c—discounted value of future expenses.

d—net present stumpage value.

(§ 127) 33. Separation of soil and timber values. Items, same as for problem 23.

Determine,

a—capital value of the present crop of standing timber independent of the final value of the soil.

b—capital value which this final soil value has if discounted to date.

c—compare the sum of these values with total value for problem 23.

d—compare separately the value of the standing timber and of the soil in each problem.

e—who gets the benefit if damages exclude full soil value.

(§ 129) 34. Additional costs of reëstablishing the new crop. Items, cost of additional slash disposal; cost of planting if necessitated by fire; net cost of salvaging dead material.

Determine,

a—damage to property expressed as difference between normal cost of reëstablishment and cost after the fire.

(§ 130) 35. Additional costs of protection. Items, cost of removal of hazard by slash disposal (problem 34); alternative cost of substituting increased annual protection; length of period over which this is required.

Determine,

a—capital cost of substituting annual fire protection.

b—comparison with cost of slash removal.

c—sum up for problems 34 and 35 the damage to soil value as measured by additional costs of reëstablishment of crop.

36. Effect of increased hazard due to non-removal of slash. Items, value of normal crop at end of a full rotation; cost of pro-

duction; normal rate p; estimated increase in required rate to x because of increased hazard.

Determine,

a—capital value of normal crop in initial year, i. e. of the crop which is established after the fire, using normal rate p.

b—resultant capital value of the same crop using increased rate x as an increase of 1 per cent over p.

c—difference in value of a and b as indication of relative value or need for slash disposal.

d—compare this appraised loss of future value with the saving in substituting annual patrol.

(§ 131) 37. Damage to soil appraised by estimating damage to succeeding crops. Items, character of new crop resulting after the fire as to species and relative value at maturity compared with crop destroyed; rate to use for capitalizing the damages, preferably the rate earned on the present crop, or x.

Determine,

a—damage by capitalizing the value of a full crop of present species and that of the resultant crop, over the rotation n, with no deduction for expenses.

b—compare damage with total present value of soil plus slash disposal in problems 34 and 35.

(§ 132) 38. Partial damage to immature timber. Items, value at maturity of the present stand if undamaged; value at maturity of the damaged stand; rate x earned by crop.

Determine,

a—present capital value of stand before damage.

b—ditto for damaged stand.

c—damage.

(§133) 39. Damage to many-aged stands. Items, interval of cutting; amount and value of yield at each successive cut; annual expenses; year of damage with reference to year of cutting; rate at which income should be capitalized; value of the forest on basis of continuous income at this rate; salvage value of burned timber. Basis, total killing of stand of all ages.

Determine,

a—net loss in value of the stand as total value less salvage value of wood.

b—loss in stumpage value and consequently in total value of the remaining unburned timber due to appraised increase in logging costs.

c—damage from *a* above, for year just after cutting.

d—for year just previous to cutting.

e—ditto for any intervening year.

Taxes.

(§ 176) 40. Taxes paid under property tax. Items, for property tax; assessed value of land; of land plus timber at intervals of reassessment until mature; tax rate.

Determine,

a—total cash taxes paid during growth of crop.

b—total of these taxes plus compound interest.

41. Taxes paid under yield tax. Items, final yield plus thinnings; rate of yield tax.

Determine,

a—amount of tax.

b—compare tax revenue from yield tax with cash income yielded by property tax.

c—compare yield tax with property taxes plus compound interest at different rates, this interest being in effect a discount allowed the owner for payment of taxes in advance of receipt of income.

42. Total taxes paid by combined land tax and yield tax. Items, value of bare land; of yield to be taxed; amount of land tax, being value times rate; rate p for interest on taxes; length of rotation.

Determine,

a—total cash taxes paid on land.

b—total land tax with interest.

c—amount of total tax plus interest which would equal 20 per cent of yield value.

d—per cent yield tax which would be equivalent with land tax plus interest to a total of 20 per cent of yield. A different total per cent can be substituted for 20 per cent in *c* and *d*.

e—per cent of yield tax necessary if interest on land tax is disregarded, to make up the required total per cent of tax on yield.

43. Special privileges in taxation accorded to individuals under contracts requiring the practice of forestry. Reduction of land values. Items, fixed or reduced value of bare land; tax rate as determined, either fixed or average yields; rate *p;* rotation.

Determine,

a—taxes paid on land, in cash.

b—taxes on land with interest.

c—comparison with land tax at normal or average value in problem 42.

d—rate of yield tax possible to make up total tax, with interest, to 20 per cent of yield, compared with problem 42.

This problem can also be applied to the case of reduced or fixed tax rate as compared to problem 42 at normal or average tax rate.

44. Rate earned on a forest investment after paying taxes under the general property tax. Items, all other costs of production as in problem 5 except taxes; taxes as in problem 40.

Determine by method of mean annual forest per cent from plotted curves of soil capital values,

a—soil capital value for each of several per cents differing by ½ per cent, substituting in each solution the given per cent for all terms in the formula including taxes.

b—curve of per cents corresponding to different soil values.

c—per cent, from curve, earned by the cost of the soil, for different soil costs.

45. Rate earned by a forest investment after paying taxes under the combined land and yield tax. Items, all other costs as in problem 5; taxes as in problem 42.

Determine, by same means as for problem 44,

a—soil capital values for different per cents.

b and *c*—as in problem 44.

d—compare the rate earned with that earned in problem 44.

(§ 190) 46. Cost of forest fire insurance. Items, insurable value at intervals during life of stand, based on market value of property less that of land; or based on costs plus interest less a discount for safety and one for density of stocking; premium rates based on species; rates for different ages of stand; rates for different hazards.

Determine,

a—total cash cost of insurance for a crop of a given age of maturity.

b—cost plus compound interest at different rates of interest.

c—compare the cost with the value of the crop, in per cent of value.

d—compare with other costs as taxes.

47. Effect of cost of insurance on the rate of interest earned. Items, all costs plus insurance.

Determine,

a—rate earned without insurance.

b—ditto with insurance.

c—if by insuring the property the rate demanded is lowered 1 to 2 per cent, what effect has insurance on the entrepreneur's probable gain.

APPENDIX B

TABLES OF COMPOUND INTEREST

Giving the value of $1.00 with interest for each .1 per cent from .1 to 6 per cent and for each .2 per cent from 6.2 to 10 per cent; for each year to 30 years, for each five years to 100 years, and for 110 and 120 years. From Kraft's Zuwachsrechnungen.

Based on formula

$$V_n = V_0(1.0p)^n$$

To find discounted values, divide by the ratios given; e. g.

$$V_0 = \frac{V_n}{(1.0p)^n}$$

To find future value of an annual rental at end of n years, capitalize the rental, and multiply by 1 less than the values in table; e. g.

$$V_n = \frac{r}{.0p}(1.0p^n - 1)$$

To find present or capital value of an annual rental payable n times, capitalize the rental and multiply by the factor $\frac{1.0p^n - 1}{1.0p^n}$; e. g.

$$V_0 = \frac{r}{.0p}\left(\frac{1.0p^n - 1}{1.0p^n}\right)$$

All the values in this table have been checked and corrected by the author. H. H. C.

Years	Values of $1.0p^n$, where $p =$									
n	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
1	1.001	1.002	1.003	1.004	1.005	1.006	1.007	1.008	1.009	1.010
2	1.002	1.004	1.006	1.008	1.010	1.012	1.014	1.016	1.018	1.020
3	1.003	1.006	1.009	1.012	1.015	1.018	1.021	1.024	1.027	1.030
4	1.004	1.008	1.012	1.016	1.020	1.024	1.028	1.032	1.036	1.041
5	1.005	1.010	1.015	1.020	1.025	1.030	1.035	1.041	1.046	1.051
6	1.006	1.012	1.018	1.024	1.030	1.037	1.043	1.049	1.055	1.062
7	1.007	1.014	1.021	1.028	1.036	1.043	1.050	1.057	1.065	1.072
8	1.008	1.016	1.024	1.032	1.041	1.049	1.057	1.066	1.074	1.083
9	1.009	1.018	1.027	1.037	1.046	1.055	1.065	1.074	1.084	1.094
10	1.010	1.020	1.030	1.041	1.051	1.062	1.072	1.083	1.094	1.105
11	1.011	1.022	1.033	1.045	1.056	1.068	1.080	1.092	1.104	1.116
12	1.012	1.024	1.037	1.049	1.062	1.074	1.087	1.100	1.114	1.127
13	1.013	1.026	1.040	1.053	1.067	1.081	1.095	1.109	1.124	1.138
14	1.014	1.028	1.043	1.057	1.072	1.087	1.103	1.118	1.134	1.149
15	1.015	1.030	1.046	1.062	1.078	1.094	1.110	1.127	1.144	1.161
16	1.016	1.032	1.049	1.066	1.083	1.100	1.118	1.136	1.154	1.173
17	1.017	1.035	1.052	1.070	1.088	1.107	1.126	1.145	1.165	1.184
18	1.018	1.037	1.055	1.075	1.094	1.113	1.134	1.154	1.175	1.196
19	1.019	1.039	1.059	1.079	1.099	1.120	1.142	1.163	1.186	1.208
20	1.020	1.041	1.062	1.083	1.105	1.127	1.150	1.173	1.196	1.220
21	1.021	1.043	1.065	1.087	1.110	1.134	1.158	1.182	1.207	1.232
22	1.022	1.045	1.068	1.092	1.116	1.141	1.166	1.192	1.218	1.245
23	1.023	1.047	1.071	1.096	1.122	1.148	1.174	1.201	1.229	1.257
24	1.024	1.049	1.075	1.101	1.127	1.154	1.182	1.211	1.240	1.270
25	1.025	1.051	1.078	1.105	1.133	1.161	1.190	1.220	1.251	1.282
26	1.026	1.053	1.081	1.109	1.138	1.168	1.199	1.230	1.262	1.295
27	1.027	1.055	1.084	1.114	1.144	1.175	1.207	1.240	1.274	1.308
28	1.028	1.058	1.087	1.118	1.150	1.182	1.216	1.250	1.285	1.321
29	1.029	1.060	1.091	1.123	1.156	1.189	1.224	1.260	1.297	1.334
30	1.030	1.062	1.094	1.127	1.161	1.197	1.233	1.270	1.308	1.348
35	1.036	1.072	1.111	1.150	1.191	1.233	1.277	1.322	1.368	1.417
40	1.041	1.083	1.127	1.173	1.221	1.270	1.322	1.375	1.431	1.489
45	1.046	1.094	1.144	1.197	1.252	1.309	1.369	1.431	1.497	1.565
50	1.051	1.105	1.162	1.221	1.283	1.349	1.417	1.490	1.565	1.645
55	1.057	1.116	1.179	1.246	1.316	1.390	1.468	1.550	1.637	1.729
60	1.062	1.127	1.197	1.271	1.349	1.432	1.520	1.613	1.712	1.817
65	1.067	1.139	1.215	1.296	1.383	1.475	1.574	1.679	1.790	1.909
70	1.072	1.150	1.233	1.322	1.418	1.520	1.630	1.747	1.872	2.007
75	1.078	1.162	1.252	1.349	1.454	1.566	1.687	1.818	1.958	2.109
80	1.083	1.173	1.271	1.376	1.490	1.614	1.747	1.892	2.048	2.217
85	1.089	1.185	1.290	1.404	1.528	1.663	1.809	1.969	2.142	2.330
90	1.094	1.197	1.309	1.432	1.567	1.713	1.874	2.049	2.240	2.449
95	1.100	1.209	1.329	1.461	1.606	1.765	1.940	2.132	2.342	2.573
100	1.105	1.221	1.349	1.491	1.647	1.819	2.009	2.219	2.450	2.705
110	1.116	1.246	1.390	1.551	1.731	1.931	2.154	2.402	2.680	2.988
120	1.127	1.271	1.433	1.615	1.819	2.050	2.310	2.602	2.931	3.300

Years	Values of $1.0p^n$, where $p =$									
n	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0
1	1.011	1.012	1.013	1.014	1.015	1.016	1.017	1.018	1.019	1.020
2	1.022	1.024	1.026	1.028	1.030	1.032	1.034	1.036	1.038	1.040
3	1.033	1.036	1.040	1.043	1.046	1.049	1.052	1.055	1.058	1.061
4	1.045	1.049	1.053	1.057	1.061	1.066	1.070	1.074	1.078	1.082
5	1.056	1.061	1.067	1.072	1.077	1.083	1.088	1.093	1.099	1.104
6	1.068	1.074	1.081	1.087	1.093	1.100	1.106	1.113	1.120	1.126
7	1.080	1.087	1.095	1.102	1.110	1.118	1.125	1.133	1.141	1.149
8	1.091	1.100	1.109	1.118	1.126	1.135	1.144	1.153	1.163	1.172
9	1.103	1.113	1.123	1.133	1.143	1.154	1.164	1.174	1.185	1.195
10	1.116	1.127	1.138	1.149	1.161	1.172	1.184	1.195	1.207	1.219
11	1.128	1.140	1.153	1.165	1.178	1.191	1.204	1.217	1.230	1.243
12	1.140	1.154	1.168	1.182	1.196	1.210	1.224	1.239	1.253	1.268
13	1.153	1.168	1.183	1.198	1.214	1.229	1.245	1.261	1.277	1.294
14	1.166	1.182	1.198	1.215	1.232	1.249	1.266	1.284	1.302	1.319
15	1.178	1.196	1.214	1.232	1.250	1.269	1.288	1.307	1.326	1.346
16	1.191	1.210	1.230	1.249	1.269	1.289	1.310	1.330	1.351	1.373
17	1.204	1.225	1.246	1.267	1.288	1.310	1.332	1.354	1.377	1.400
18	1.218	1.240	1.262	1.284	1.307	1.331	1.355	1.379	1.403	1.428
19	1.231	1.254	1.278	1.302	1.327	1.352	1.378	1.404	1.430	1.457
20	1.245	1.269	1.295	1.321	1.347	1.374	1.401	1.429	1.457	1.486
21	1.258	1.285	1.312	1.339	1.367	1.396	1.425	1.455	1.485	1.516
22	1.272	1.300	1.329	1.358	1.388	1.418	1.449	1.481	1.513	1.546
23	1.286	1.316	1.346	1.377	1.408	1.441	1.474	1.507	1.542	1.577
24	1.300	1.331	1.363	1.396	1.429	1.464	1.499	1.535	1.571	1.608
25	1.315	1.347	1.381	1.416	1.451	1.487	1.524	1.562	1.601	1.641
26	1.329	1.364	1.399	1.435	1.473	1.511	1.550	1.590	1.631	1.673
27	1.343	1.380	1.417	1.456	1.495	1.535	1.576	1.619	1.662	1.707
28	1.358	1.397	1.436	1.476	1.517	1.560	1.603	1.648	1.694	1.741
29	1.373	1.413	1.454	1.497	1.540	1.585	1.631	1.678	1.726	1.776
30	1.388	1.430	1.473	1.518	1.563	1.610	1.658	1.708	1.759	1.811
35	1.467	1.518	1.572	1.627	1.684	1.743	1.804	1.867	1.932	2.000
40	1.549	1.611	1.676	1.744	1.814	1.887	1.963	2.041	2.123	2.208
45	1.636	1.710	1.788	1.869	1.954	2.043	2.135	2.232	2.333	2.438
50	1.728	1.816	1.908	2.004	2.105	2.212	2.323	2.440	2.563	2.692
55	1.825	1.927	2.035	2.148	2.268	2.394	2.527	2.668	2.816	2.972
60	1.928	2.046	2.170	2.303	2.443	2.592	2.750	2.917	3.093	3.281
65	2.036	2.171	2.315	2.469	2.632	2.806	2.991	3.189	3.399	3.623
70	2.151	2.305	2.470	2.646	2.835	3.038	3.254	3.486	3.734	4.000
75	2.272	2.446	2.635	2.837	3.055	3.289	3.541	3.811	4.103	4.416
80	2.399	2.597	2.810	3.041	3.291	3.560	3.852	4.167	4.508	4.875
85	2.534	2.756	2.998	3.260	3.545	3.854	4.191	4.556	4.952	5.383
90	2.677	2.926	3.198	3.495	3.819	4.173	4.559	4.981	5.441	5.943
95	2.827	3.106	3.411	3.746	4.114	4.518	4.960	5.446	5.978	6.562
100	2.986	3.296	3.638	4.016	4.432	4.891	5.396	5.954	6.568	7.245
110	3.331	3.714	4.140	4.615	5.144	5.732	6.387	7.117	7.928	8.831
120	3.717	4.185	4.701	5.303	5.969	6.718	7.560	8.506	9.570	10.77

Years	Values of $1.0p^n$, where $p =$									
n	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0
1	1.021	1.022	1.023	1.024	1.025	1.026	1.027	1.028	1.029	1.030
2	1.043	1.045	1.047	1.049	1.051	1.053	1.055	1.057	1.059	1.061
3	1.064	1.068	1.071	1.074	1.077	1.080	1.083	1.086	1.090	1.093
4	1.087	1.091	1.095	1.100	1.104	1.108	1.113	1.117	1.121	1.126
5	1.110	1.115	1.120	1.126	1.131	1.137	1.142	1.148	1.154	1.159
6	1.133	1.140	1.146	1.153	1.160	1.167	1.173	1.180	1.187	1.194
7	1.157	1.165	1.173	1.181	1.189	1.197	1.205	1.213	1.222	1.230
8	1.181	1.190	1.200	1.209	1.218	1.228	1.238	1.247	1.257	1.267
9	1.206	1.216	1.227	1.238	1.249	1.260	1.271	1.282	1.293	1.305
10	1.231	1.243	1.255	1.268	1.280	1.293	1.305	1.318	1.331	1.344
11	1.257	1.271	1.284	1.298	1.312	1.326	1.341	1.355	1.370	1.384
12	1.283	1.299	1.314	1.329	1.345	1.361	1.377	1.393	1.409	1.426
13	1.310	1.327	1.344	1.361	1.379	1.396	1.414	1.432	1.450	1.468
14	1.338	1.356	1.375	1.394	1.413	1.433	1.452	1.472	1.492	1.513
15	1.366	1.386	1.407	1.427	1.448	1.470	1.491	1.513	1.536	1.558
16	1.395	1.417	1.439	1.462	1.485	1.508	1.532	1.556	1.580	1.605
17	1.424	1.448	1.472	1.497	1.522	1.547	1.573	1.599	1.626	1.653
18	1.454	1.480	1.506	1.533	1.560	1.587	1.615	1.644	1.673	1.702
19	1.484	1.512	1.540	1.569	1.599	1.629	1.659	1.690	1.721	1.753
20	1.515	1.545	1.576	1.607	1.639	1.671	1.704	1.737	1.771	1.806
21	1.547	1.579	1.612	1.646	1.680	1.714	1.750	1.786	1.823	1.860
22	1.580	1.614	1.649	1.685	1.722	1.759	1.797	1.836	1.876	1.916
23	1.613	1.650	1.687	1.726	1.765	1.805	1.846	1.887	1.930	1.974
24	1.647	1.686	1.726	1.767	1.809	1.852	1.895	1.940	1.986	2.033
25	1.681	1.723	1.766	1.809	1.854	1.900	1.947	1.995	2.044	2.094
26	1.717	1.761	1.806	1.853	1.900	1.949	1.999	2.050	2.103	2.157
27	1.753	1.800	1.848	1.897	1.948	2.000	2.053	2.108	2.164	2.221
28	1.790	1.839	1.890	1.943	1.997	2.052	2.109	2.167	2.227	2.288
29	1.827	1.880	1.934	1.989	2.046	2.105	2.165	2.227	2.291	2.357
30	1.865	1.921	1.978	2.037	2.098	2.160	2.224	2.290	2.358	2.427
35	2.070	2.142	2.216	2.294	2.373	2.456	2.541	2.629	2.720	2.814
40	2.296	2.388	2.483	2.582	2.685	2.792	2.903	3.018	3.138	3.362
45	2.548	2.662	2.782	2.907	3.038	3.174	3.316	3.465	3.620	3.782
50	2.827	2.969	3.117	3.274	3.437	3.609	3.789	3.978	4.176	4.384
55	3.136	3.310	3.493	3.686	3.889	4.103	4.329	4.567	4.818	5.082
60	3.480	3.690	3.913	4.150	4.400	4.665	4.946	5.243	5.558	5.892
65	3.861	4.115	4.385	4.672	4.978	5.303	5.650	6.019	6.412	6.830
70	4.284	4.587	4.912	5.260	5.632	6.030	6.455	6.911	7.397	7.918
75	4.753	5.115	5.504	5.923	6.372	6.856	7.375	7.934	8.534	9.179
80	5.273	5.703	6.167	6.668	7.210	7.794	8.426	9.109	9.845	10.64
85	5.851	6.358	6.909	7.508	8.157	8.861	9.627	10.46	11.36	12.34
90	6.491	7.089	7.742	8.453	9.229	10.08	11.00	12.01	13.10	14.30
95	7.202	7.904	8.674	9.517	10.44	11.46	12.57	13.78	15.12	16.58
100	7.991	8.812	9.718	10.72	11.81	13.02	14.36	15.82	17.44	19.22
110	9.837	10.95	12.20	13.58	15.12	16.83	18.74	20.86	23.21	25.83
120	12.11	13.62	15.31	17.22	19.36	21.76	24.46	27.49	30.89	34.71

Years	Values of $1.0p^n$, where $p =$									
n	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0
1	1.031	1.032	1.033	1.034	1.035	1.036	1.037	1.038	1.039	1.040
2	1.063	1.065	1.067	1.070	1.071	1.073	1.075	1.077	1.080	1.082
3	1.096	1.099	1.102	1.106	1.109	1.112	1.115	1.118	1.122	1.125
4	1.130	1.134	1.139	1.143	1.148	1.152	1.157	1.161	1.165	1.170
5	1.165	1.171	1.176	1.182	1.188	1.194	1.199	1.205	1.211	1.217
6	1.201	1.208	1.215	1.222	1.229	1.236	1.244	1.251	1.258	1.265
7	1.238	1.247	1.255	1.264	1.272	1.281	1.290	1.298	1.307	1.316
8	1.277	1.287	1.297	1.307	1.317	1.327	1.337	1.348	1.358	1.369
9	1.316	1.328	1.339	1.351	1.363	1.375	1.387	1.399	1.411	1.423
10	1.357	1.370	1.384	1.397	1.411	1.424	1.438	1.452	1.466	1.480
11	1.399	1.414	1.429	1.445	1.460	1.476	1.491	1.507	1.523	1.539
12	1.443	1.459	1.476	1.494	1.511	1.529	1.547	1.565	1.583	1.601
13	1.487	1.506	1.525	1.545	1.564	1.584	1.604	1.624	1.644	1.665
14	1.533	1.554	1.576	1.597	1.619	1.641	1.663	1.686	1.709	1.732
15	1.581	1.604	1.628	1.651	1.675	1.700	1.725	1.750	1.775	1.801
16	1.630	1.655	1.681	1.707	1.734	1.761	1.788	1.816	1.844	1.873
17	1.680	1.708	1.737	1.766	1.795	1.824	1.855	1.885	1.916	1.948
18	1.732	1.763	1.794	1.826	1.857	1.890	1.924	1.957	1.991	2.026
19	1.786	1.819	1.853	1.888	1.923	1.958	1.994	2.031	2.069	2.107
20	1.842	1.878	1.914	1.952	1.990	2.029	2.068	2.108	2.149	2.191
21	1.899	1.938	1.978	2.018	2.059	2.102	2.145	2.189	2.233	2.279
22	1.958	2.000	2.043	2.087	2.132	2.177	2.224	2.272	2.320	2.370
23	2.018	2.064	2.110	2.158	2.206	2.256	2.306	2.358	2.411	2.465
24	2.081	2.130	2.180	2.231	2.283	2.337	2.392	2.448	2.505	2.563
25	2.145	2.198	2.252	2.307	2.363	2.421	2.480	2.541	2.603	2.666
26	2.212	2.268	2.326	2.385	2.446	2.508	2.572	2.637	2.704	2.772
27	2.280	2.341	2.403	2.467	2.532	2.599	2.667	2.737	2.810	2.883
28	2.351	2.416	2.482	2.550	2.620	2.692	2.766	2.841	2.919	2.999
29	2.424	2.493	2.564	2.637	2.712	2.789	2.868	2.949	3.033	3.119
30	2.499	2.573	2.649	2.727	2.807	2.889	2.974	3.061	3.151	3.243
35	2.911	3.012	3.115	3.223	3.334	3.448	3.567	3.689	3.815	3.946
40	3.391	3.525	3.664	3.809	3.959	4.115	4.277	4.445	4.620	4.801
45	3.951	4.127	4.310	4.502	4.702	4.911	5.129	5.357	5.594	5.841
50	4.602	4.831	5.070	5.322	5.585	5.861	6.151	6.455	6.773	7.107
55	5.361	5.655	5.964	6.290	6.633	6.995	7.376	7.778	8.201	8.646
60	6.245	6.619	7.015	7.435	7.878	8.348	8.846	9.373	9.930	10.52
65	7.275	7.748	8.251	8.787	9.357	9.963	10.61	11.29	12.02	12.80
70	8.475	9.070	9.705	10.39	11.11	11.89	12.72	13.59	14.56	15.57
75	9.872	10.62	11.42	12.28	13.20	14.19	15.26	16.40	17.63	18.95
80	11.50	12.43	13.43	14.51	15.68	16.94	18.29	19.76	21.34	23.05
85	13.40	14.55	15.80	17.15	18.62	20.21	21.94	23.81	25.84	28.04
90	15.61	17.03	18.58	20.27	22.11	24.12	26.31	28.69	31.29	34.12
95	18.18	19.93	21.85	23.96	26.26	28.79	31.55	34.58	37.89	41.51
100	21.18	23.33	25.70	28.32	31.19	34.36	37.83	41.66	45.87	50.50
110	28.74	31.97	35.57	39.56	44.00	48.93	54.41	60.50	67.26	74.76
120	39.00	43.81	49.21	55.27	62.06	69.69	78.25	87.84	98.61	110.7

Years	Values of $1.0p^n$, where $p =$									
n	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0
1	1.041	1.042	1.043	1.044	1.045	1.046	1.047	1.048	1.049	1.050
2	1.083	1.086	1.088	1.090	1.092	1.094	1.096	1.098	1.100	1.103
3	1.128	1.131	1.135	1.138	1.141	1.145	1.148	1.151	1.154	1.158
4	1.174	1.179	1.184	1.188	1.193	1.197	1.202	1.206	1.211	1.216
5	1.223	1.228	1.234	1.240	1.246	1.252	1.258	1.264	1.270	1.276
6	1.273	1.280	1.287	1.295	1.302	1.310	1.317	1.325	1.333	1.340
7	1.325	1.334	1.343	1.352	1.361	1.370	1.379	1.389	1.398	1.407
8	1.379	1.390	1.401	1.411	1.422	1.433	1.444	1.455	1.466	1.478
9	1.436	1.448	1.461	1.473	1.486	1.499	1.512	1.525	1.539	1.551
10	1.495	1.509	1.524	1.539	1.553	1.568	1.583	1.598	1.614	1.629
11	1.556	1.573	1.589	1.606	1.623	1.640	1.657	1.675	1.693	1.710
12	1.620	1.638	1.657	1.677	1.696	1 716	1.735	1.755	1.776	1.796
13	1.686	1.707	1.729	1.750	1.772	1.794	1.817	1.840	1.863	1.886
14	1.755	1.779	1.803	1.827	1.852	1.877	1.902	1.928	1.954	1.980
15	1.827	1.854	1.881	1.908	1.935	1.963	1.992	2.020	2.050	2.079
16	1.902	1.932	1.961	1.992	2.022	2.054	2.085	2.117	2.150	2.183
17	1.980	2.013	2.046	2.079	2.113	2.148	2.183	2.219	2.255	2.292
18	2.061	2.097	2.134	2.171	2.208	2.247	2.286	2.326	2.366	2.407
19	2.146	2.185	2.225	2.266	2.308	2.350	2.393	2.437	2.482	2.527
20	2.234	2.277	2.321	2.366	2.412	2.458	2.506	2.554	2.603	2.653
21	2.325	2.373	2.421	2.459	2.520	2.571	2.624	2.677	2.731	2.786
22	2.421	2.472	2.525	2.579	2.634	2.690	2.747	2.805	2.865	2.925
23	2.520	2.576	2.634	2.692	2.752	2.813	2.876	2.940	3.005	3.072
24	2.623	2.684	2.747	2.811	2.876	2.943	3.011	3.081	3.152	3.225
25	2.731	2.797	2.865	2.934	3.005	3.078	3.153	3.229	3.307	3.386
26	2.843	2.915	2.988	3.064	3.141	3.220	3.301	3.384	3.469	3.556
27	2.959	3.037	3.117	3.198	3.282	3.368	3.456	3.546	3.639	3.733
28	3.081	3.164	3.251	3.339	3.430	3.523	3.618	3.716	3.817	3.920
29	3.207	3.297	3.390	3.486	3.584	3.685	3.788	3.895	4.004	4.116
30	3.338	3.436	3.536	3.640	3.745	3.854	3.967	4.082	4.200	4.322
35	4.081	4.221	4.365	4.514	4.667	4.826	4.990	5.160	5.335	5.516
40	4.989	5.185	5.387	5.598	5.816	6.043	6.279	6.523	6.777	7.040
45	6.099	6.369	6.650	6.943	7.248	7.567	7.900	8.246	8.608	8.985
50	7.457	7.823	8.208	8.611	9.033	9.475	9.939	10.43	10.93	11.47
55	9.116	9.610	10.13	10.68	11.26	11.87	12.51	13.18	13.89	14.64
60	11.15	11.81	12.51	13.25	14.03	14.86	15.73	16.66	17.64	18.68
65	13.62	14.50	15.44	16.43	17.48	18.60	19.79	21.06	22.41	23.84
70	16.66	17.81	19.05	20.37	21.78	23.29	24.90	26.63	28.46	30.43
75	20.36	21.88	23.52	25.27	27.15	29.17	31.33	33.66	36.16	38.83
80	24.89	26.88	29.03	31.34	33.83	36.52	39.42	42.55	45.93	49.56
85	30.43	33.02	35.82	38.86	42.16	45.73	49.60	53.79	58.33	63.25
90	37.20	40.56	44.22	48.20	52.54	57.26	62.41	68.00	74.10	80.73
95	45.48	49.82	54.58	59.78	65.47	71.70	78.51	85.97	94.12	103.0
100	55.60	61.20	67.37	74.14	81.59	89.78	98.78	108.7	119.6	131.5
110	83.10	92.35	102.6	114.0	126.7	140.8	156.4	173.7	192.9	214.2
120	124.2	139.4	156.4	175.4	196.8	220.7	247.5	277.5	311.2	348.9

Years	Values of $1.0p^n$, where $p =$									
n	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	6.0
1	1.051	1.052	1.053	1.054	1.055	1.056	1.057	1.058	1.059	1.060
2	1.105	1.107	1.109	1.111	1.113	1.115	1.117	1.119	1.122	1.124
3	1.161	1.164	1.168	1.171	1.174	1.178	1.181	1.184	1.188	1.191
4	1.220	1.225	1.230	1.234	1.239	1.244	1.248	1.253	1.258	1.262
5	1.282	1.289	1.295	1.301	1.307	1.313	1.319	1.326	1.332	1.338
6	1.348	1.356	1.363	1.371	1.379	1.387	1.395	1.403	1.411	1.419
7	1.417	1.426	1.436	1.445	1.455	1.464	1.474	1.484	1.494	1.504
8	1.489	1.500	1.512	1.523	1.535	1.547	1.558	1.570	1.582	1.594
9	1.565	1.578	1.592	1.605	1.619	1.633	1.647	1.661	1.675	1.689
10	1.645	1.660	1.676	1.692	1.708	1.724	1.741	1.757	1.774	1.791
11	1.729	1.747	1.765	1.783	1.802	1.821	1.840	1.859	1.879	1.898
12	1.817	1.837	1.859	1.880	1.901	1.923	1.945	1.967	1.990	2.012
13	1.909	1.933	1.957	1.981	2.006	2.031	2.056	2.081	2.107	2.133
14	2.007	2.033	2.061	2.088	2.116	2.144	2.173	2.202	2.231	2.261
15	2.109	2.139	2.170	2.201	2.233	2.265	2.297	2.330	2.363	2,397
16	2.216	2.250	2.285	2.320	2.355	2.391	2.428	2.465	2.502	2.540
17	2.329	2.367	2.406	2.445	2.485	2.525	2.566	2.608	2.650	2.693
18	2.448	2.491	2.534	2.577	2.621	2.667	2.712	2.759	2.806	2.854
19	2.573	2.620	2.668	2.716	2.766	2.815	2.867	2.919	2.972	3.026
20	2.704	2.756	2.809	2.863	2.918	2.974	3.030	3.088	3.147	3.207
21	2.842	2.900	2.958	3.018	3.078	3.140	3.203	3.267	3.383	3.400
22	2.987	3.050	3.115	3.181	3.248	3.316	3.386	3.457	3.530	3.604
23	3.136	3.209	3.280	3.352	3.426	3.502	3.579	3.657	3.738	3.820
24	3.300	3.376	3.454	3.533	3.615	3.698	3.783	3.870	3.958	4.049
25	3.468	3.551	3.637	3.724	3.813	3.905	3.998	4.094	4.192	4.292
26	3.645	3.736	3.830	3.925	4.023	4.124	4.226	4.332	4.439	4.550
27	3.831	3.930	4.033	4.137	4.244	4.354	4.467	4.583	4.701	4.822
28	4.026	4.135	4.246	4.361	4.478	4.598	4.722	4.850	4.978	5.112
29	4.231	4.350	4.471	4.596	4.724	4.856	4.993	5.130	5.272	5.418
30	4.447	4.576	4.708	4.844	4.984	5.128	5.275	5.427	5.583	5.744
35	5.703	5.896	6.095	6.301	6.514	6.734	6.960	7.195	7.436	7.686
40	7.313	7.596	7.891	8.197	8.513	8.842	9.184	9.537	9.905	10.29
45	9.378	9.788	10.22	10.66	11.13	11.61	12.12	12.64	13.19	13.77
50	12.03	12.61	13.23	13.87	14.54	15.25	15.99	16.76	17.57	18.42
55	15.42	16.25	17.12	18.04	19.00	20.02	21.09	22.23	23.40	24.65
60	19.78	20.94	22.17	23.47	24.84	26.29	27.83	29.45	31.17	32.99
65	25.36	26.94	28.70	30.52	32.46	34.53	36.72	39.05	41.52	44.15
70	32.52	34.76	37.15	39.71	42.43	45.34	48.45	51.76	55.30	59.08
75	41.71	44.79	48.10	51.65	55.45	59.54	63.92	68.62	73.66	79.06
80	53.48	57.71	62.27	67.18	72.47	78.18	84.33	90.96	98.10	105.8
85	68.59	74.36	80.62	87.38	94.72	102.7	111.3	120.6	130.6	141.6
90	87.95	95.81	104.4	113.7	123.8	134.8	146.8	159.9	174.0	189.5
95	112.8	123.4	135.1	147.9	161.8	177.0	193.7	211.9	231.8	253.6
100	144.6	159.1	174.9	192.3	211.4	232.5	255.6	280.9	308.7	339.3
110	237.9	264.1	293.2	325.4	361.2	400.9	444.9	493.7	547.7	607.7
120	391.1	438.4	491.4	550.7	617.0	691.3	774.3	867.5	971.7	1088

Years	Values of $1.0p^n$, where $p =$									
n	6.2	6.4	6.6	6.8	7.0	7.2	7.4	7.6	7.8	8.0
1	1.062	1.064	1.066	1.068	1.070	1.072	1.074	1.076	1.078	1.080
2	1.127	1.132	1.136	1.141	1.145	1.149	1.154	1.158	1.162	1.166
3	1.198	1.205	1.211	1.218	1.225	1.232	1.239	1.246	1.253	1.260
4	1.272	1.282	1.291	1.301	1.311	1.321	1.331	1.341	1.351	1.361
5	1.351	1.364	1.377	1.390	1.403	1.416	1.429	1.442	1.456	1.469
6	1.435	1.451	1.467	1.484	1.501	1.518	1.535	1.552	1.569	1.587
7	1.524	1.544	1.564	1.585	1.606	1.627	1.648	1.670	1.692	1.714
8	1.618	1.643	1.668	1.693	1.718	1.744	1.770	1.797	1.824	1.851
9	1.718	1.748	1.778	1.808	1.839	1.870	1.901	1.933	1.966	1.999
10	1.825	1.860	1.895	1.931	1.967	2.004	2.042	2.080	2.119	2.159
11	1.938	1.979	2.020	2.062	2.105	2.149	2.193	2.238	2.285	2.332
12	2.058	2.105	2.153	2.202	2.252	2.303	2.355	2.409	2.463	2.518
13	2.186	2.240	2.295	2.352	2.410	2.469	2.530	2.592	2.655	2.720
14	2.321	2.383	2.447	2.512	2.579	2.647	2.716	2.789	2.862	2.937
15	2.465	2.535	2.608	2.683	2.759	2.838	2.918	3.001	3.085	3.172
16	2.618	2.698	2.781	2.865	2.952	3.042	3.133	3.229	3.326	3.426
17	2.781	2.870	2.964	3.060	3.159	3.261	3.366	3.474	3.585	3.700
18	2.953	3.055	3.160	3.268	3.380	3.496	3.615	3.738	3.865	3.996
19	3.136	3.250	3.368	3.490	3.617	3.747	3.882	4.022	4.166	4.316
20	3.330	3.458	3.590	3.728	3.870	4.017	4.170	4.328	4.491	4.661
21	3.537	3.679	3.827	3.981	4.141	4.306	4.478	4.657	4.842	5.034
22	3.756	3.915	4.080	4.252	4.430	4.616	4.810	5.010	5.219	5.437
23	3.989	4.165	4.349	4.541	4.741	4.949	5.165	5.391	5.627	5.872
24	4.236	4.432	4.636	4.850	5.072	5.305	5.548	5.801	6.065	6.341
25	4.499	4.716	4.942	5.180	5.428	5.687	5.958	6.242	6.538	6.849
26	4.778	5.018	5.269	5.532	5.807	6.096	6.399	6.716	7.048	7.396
27	5.074	5.339	5.616	5.908	6.214	6.535	6.873	7.227	7.598	7.988
28	5.389	5.680	5.987	6.310	6.649	7.005	7.381	7.776	8.191	8.627
29	5.723	6.044	6.382	6.739	7.114	7.510	7.927	8.367	8.830	9.317
30	6.078	6.431	6.803	7.197	7.612	8.051	8.514	9.003	9.518	10.06
35	8.210	8.769	9.365	10.00	10.68	11.40	12.17	12.99	13.86	14.79
40	11.09	11.96	12.89	13.90	14.98	16.14	17.39	18.73	20.17	21.73
45	14.98	16.31	17.75	19.31	21.00	22.85	24.84	27.01	29.37	31.92
50	20.24	22.24	24.43	26.82	29.46	32.34	35.50	38.96	42.75	46.90
55	27.34	30.33	33.62	37.28	41.32	45.79	50.73	56.19	62.24	68.92
60	36.94	41.37	46.29	51.79	57.95	64.82	72.49	81.05	90.60	101.3
65	49.90	56.39	63.71	71.97	81.27	91.76	103.5	116.9	131.9	148.8
70	67.41	76.90	87.70	100.0	114.0	129.9	148.0	168.6	192.0	218.6
75	91.06	104.9	120.7	139.0	159.9	183.9	211.5	243.2	279.5	321.2
80	123.0	143.0	166.2	193.1	224.2	260.4	302.2	350.7	406.9	472.0
85	166.2	195.0	228.8	268.3	314.5	368.6	431.9	505.8	592.4	693.5
90	224.5	265.9	314.9	372.8	441.1	521.8	617.1	729.6	862.4	1019
95	303.3	362.6	433.5	517.9	618.7	738.8	881.9	1052	1256	1497
100	409.7	494.5	596.7	719.7	867.8	1046	1260	1518	1828	2200

Years	Values of $1.0p^n$, where $p =$									
n	8.2	8.4	8.6	8.8	9.0	9.2	9.4	9.6	9.8	10
1	1.082	1.084	1.086	1.088	1.090	1.092	1.094	1.096	1.098	1.100
2	1.171	1.175	1.179	1.184	1.188	1.193	1.197	1.201	1.206	1.210
3	1.267	1.274	1.281	1.288	1.295	1.302	1.309	1.317	1.324	1.331
4	1.371	1.381	1.391	1.401	1.412	1.422	1.432	1.443	1.454	1.464
5	1.483	1.497	1.511	1.525	1.539	1.553	1.567	1.582	1.596	1.611
6	1.605	1.623	1.641	1.659	1.677	1.696	1.714	1.733	1.752	1.772
7	1.736	1.759	1.782	1.805	1.828	1.852	1.876	1.900	1.924	1.949
8	1.878	1.907	1.935	1.964	1.993	2.022	2.052	2.082	2.113	2.144
9	2.033	2.067	2.101	2.136	2.172	2.208	2.245	2.282	2.320	2.358
10	2.199	2.240	2.282	2.324	2.367	2.411	2.456	2.501	2.547	2.594
11	2.380	2.429	2.478	2.529	2.581	2.633	2.687	2.741	2.797	2.853
12	2.575	2.632	2.691	2.751	2.813	2.875	2.939	3.004	3.071	3.139
13	2.786	2.854	2.923	2.994	3.066	3.140	3.215	3.293	3.372	3.452
14	3.014	3.093	3.174	3.257	3.342	3.429	3.518	3.609	3.702	3.798
15	3.262	3.353	3.447	3.544	3.643	3.744	3.848	3.955	4.065	4.177
16	3.529	3.635	3.744	3.855	3.970	4.089	4.210	4.334	4.463	4.595
17	3.818	3.940	4.066	4.195	4.328	4.465	4.606	4.751	4.901	5.055
18	4.131	4.271	4.415	4.564	4.417	4.875	5.038	5.207	5.381	5.560
19	4.470	4.630	4.795	4.965	5.142	5.324	5.512	5.707	5.908	6.116
20	4.837	5.019	5.207	5.402	5.605	5.814	6.030	6.254	6.487	6.728
21	5.233	5.440	5.655	5.878	6.109	6.349	6.597	6.855	7.123	7.400
22	5.662	5.897	6.141	6.395	6.659	6.933	7.217	7.513	7.821	8.140
23	6.127	6.393	6.669	6.958	7.258	7.571	7.896	8.235	8.587	8.954
24	6.629	6.930	7.243	7.570	7.911	8.267	8.638	9.025	9.429	9.850
25	7.173	7.512	7.866	8.236	8.623	9.028	9.450	9.892	10.35	10.83
26	7.761	8.143	8.542	8.961	9.399	9.858	10.34	10.84	11.37	11.92
27	8.397	8.827	9.277	9.750	10.25	10.77	11.31	11.88	12.48	13.11
28	9.086	9.568	10.08	10.61	11.17	11.76	12.37	13.02	13.71	14.42
29	9.831	10.37	10.94	11.54	12.17	12.84	13.54	14.27	15.05	15.86
30	10.64	11.24	11.88	12.56	13.27	14.03	14.81	15.64	16.52	17.45
35	15.78	16.83	17.95	19.14	20.41	21.77	23.21	24.73	26.37	28.10
40	23.39	25.19	27.11	29.19	31.41	33.80	36.37	39.12	42.08	45.26
45	34.69	37.70	40.96	44.49	48.33	52.48	56.99	61.87	67.16	72.89
50	51.45	56.43	61.87	67.83	74.36	81.50	89.30	97.84	107.2	117.4
55	76.30	84.45	93.46	103.4	114.4	126.6	140.0	154.7	171.1	189.1
60	113.2	126.4	141.2	157.7	176.0	196.5	219.3	244.7	273.0	304.5
65	167.8	189.2	213.3	240.4	270.8	305.1	343.7	387.0	435.7	490.4
70	248.8	283.2	322.2	366.5	416.7	473.8	538.5	612.0	695.3	789.8
75	369.0	423.8	486.7	558.7	641.2	735.7	843.9	967.8	1110	1272
80	547.3	634.4	735.2	851.8	986.6	1142	1323	1531	1771	2049

ERRATA

Page 55—For final table, substitute:

Years required to increase 20 fold	Annual rate earned: Simple interest per cent	Annual rate earned: Compound interest per cent	Ratio of rate of compound interest to rate of simple interest
5	380.0	82.0	.22
10	190.0	34.9	.18
20	95.0	16.2	.17
50	38.0	6.2	.16
100	19.0	3.05	.16

Page 59, line 11—For "stumpage" read "stump"

Page 65, line 19—For "of" read "or"

Page 97, line 33—For "affecting" read "offsetting"

Page 116, line 21—For "$Y + ee$" read "$Y - ee$"

Page 120, line 17—Eliminate "As"

Page 145—For calculation of x per cent substitute the following below the first line of the calculation:

$$= \log.\frac{13.739}{50} = \frac{1.137956}{50} = .022759$$

$$1.0x = 1.0538 \qquad x = 5.38 \text{ per cent}$$

Substituting 5.38 for x, $\quad \frac{e}{.0x} = 5.57$

$$\log. 1.0x = \log. \frac{410.00 + 5.57}{10.00 + 15.00 + 5.57} \div 50$$

$$= \frac{\log. 13.594}{50} = \frac{1.33347}{50} = .022666$$

$$1.0x = 1.0536 \qquad x = 5.36 \text{ per cent}$$

"The true value of x is evidently about 5.35 per cent.

Instead of using logarithms, the rate corresponding to $1.0x^n$ may be found in the table, Appendix B opposite n years, (in this case 50 years) for each trial, and the new value of x used in recomputing that of $\frac{e}{.0x}$ as above."

Page 189, line 17—For "1.05^{50}" read "1.055^{50}"

Page 249, bottom of page—For calculation of q' read:

$$.0q = .20$$

$$.0q' = \frac{.20}{1 + .20} = .16\tfrac{2}{3}$$

$$q = 16\tfrac{2}{3} \text{ per cent}$$

Page 277—Table VI, headings
for "of $98.00" read "or $98.00"
line 6, for "27.00" read "37.00"

Page 278—Table VII, headings
for "of $98.00" read "or $98.00"

INDEX

PAGE

Abstinence, principle of 40
Accounting 15
unit of, in forestry 101
Additional cost of establishing new crop as damages 186
protection, as damage 187
damage to land 185
Adjustment of loss in insurance 303
Aesthetic values, damage to 195
Agricultural products 5
Alternatives of industry in obtaining wood 7
Annual income, capital value of a forest producing 113
importance of 44
rates of 44
operating income versus accumulating costs 75
rate earned 40
as basis of comparison of profits 52
Appraisals 35
of damages based on capital value 161
cost value 164
market value 165
physical basis 167
principles underlying 160
to forest property 175
immature timber, damages 171
market values 132
merchantable timber in damages 170
soil value 167
stumpage value, basis 206
stumpage. *See stumpage appraisals.*
stumpage 213
importance of use of average figures 213
of young timber, rate earned, as basis 150
Areas, purchase 130
Average and deferred profits 51

Bankruptcy 19
Basic rate of interest in forestry 92
Basis for computing profits, the investment 47
values in land 46
of appraisal of stumpage value 206
damages, capital value 161
cost value 164
market value 165
physical 167
possession and use 161

PAGE

Basis of investment in forest enterprise, rates earned as 85
market values 131
operating income, the business unit 73
stumpage values 197
economic 200
physical 198
value for forest property 1
valuation, the present moment 41
Benefit, as a source of value 34
Borrowed capital, guarantee of interest on 21
Business enterprise 17
the flow of capital through the 20
unit the basis of operating income 73

Capital assets, liquidation 74
guarantee of interest on borrowed 21
interest rate as commodity price for 80
invested in land, changes in value of 48
investment in timber lands 96
returns to 21
the flow through the business 20
value 28
considerations affecting 111
of an even-aged stand of timber 122
a forest producing annual income 113
whose income is not continuous 116
bare soil 126
damages 161
forest property 111
productive land 83
single stands of timber whose income is deferred 118
values, profits in terms of 56
working 19
Capitalized income value 28
rental value 28
Change in stumpage values 203
value of money 49
Changes in value of capital invested in land 48
Character of a business enterprise 17
Characteristics of cost value in forestry 95
insurance 295
Circle of effort 18
Climatic hazard 290
injuries 293
Co-insurance 301
Commercial values 2
Commodity price for capital, interest rate as 80

PAGE
Comparison of profits on basis of annual rate earned 52
Compound interest and discount 39
not guaranteed 37
on money capital versus the rate of interest 89
rate of, versus ratio of profit 89
versus law of diminishing returns 87
Computation of property taxes 283
Concessions in forest taxation, general 281
special 282
to private owners in taxation 276
Conflagration hazard 292
Conservation of energy 7
Considerations affecting capital value 111
Continuity of income 72
Contract relations in forest taxation 282
Conversion of intermittent into annual rentals 70
Cost accounting 25
accounts 24
a true 25
of establishing crop 98
producing a timber crop 108
reëstablishing new crop, as damages 186
replacement, as a basis of insurance 302
supervision, in forestry 103
marginal 29
value 28, 95
for a forest which is a going concern 104
with deferred income 105
of damages 164
speculative timber holdings and single stands 107
relation to use and market value 31
versus use value 28
values of forest property 95
versus value of stumpage 209
Costs, accumulating, versus annual operating income 75
of protection as a measure of damages 187
in stumpage appraisals 203
insurance 305
operating, annual expenses, protection 101
in forestry 98
overhead or general expense 102
taxes 102
Creating a going concern in forestry 73
Credit 19
Creditors 50
Crop, cost of establishment 98
timber, cost of producing 108

PAGE

Current income, rates of 44
Damage, additional costs of, protection 187
to immature timber, partial 189
many-aged stands 190
merchantable timber 175
soil 185
appraised by estimating damage to succeeding crop 188
timber which cannot be logged immediately 176
watersheds 194
total destruction of immature timber 180
Damages, appraisal 172
of immature timber 171
merchantable timber 170
principles underlying 160
appraisals, based on capital value 163
cost value 164
method of settlement for 161
punitive 196
soil value 167
to forest property, appraisal 175
university principle of 160
Debtors 50
Deferred income, cost value for a forest with 105
profits 51
returns, rate earned by 140
Dependence of value on utilized energy 36
Depletion, charge for 101
Depreciation. *See stumpage appraisals.*
Depreciation 19
Destruction of immature timber, total damage 180
Destructive lumbering, capital value for 116
tendencies 99
of private ownership 9
Determination of profits in land enterprises 46
rate earned 42
Deterrents of private forestry 8
Diminishing returns, law of 87
Direct appraisal of rate of annual profit 56
Discount 38
Discontinuance of production or of consumption 30
Diseases, fungus, hazard 293
Dividends 20, 51
Dynamic forces 12
processes 20

Earned income versus withdrawn 51
Economic accounting 24

PAGE
Economic basis for forestry, the 1
of stumpage values 200
consequences of forest destruction 6
principles underlying forest finance 27
theory of rent 32
Economics, forest 14
Effect of monetary changes 49
rate earned on value 71
Effort or cost, the source of value 34
Endothia parasitica 293
Enterprise, the business 17
Entrepreneur, definition 23
Entrepreneur's gain expressed as a margin of rate earned over rate of interest 90
and rate of interest 80
factors determining the 82
in a going concern 104
in forest investments 155
in forestry 84
versus profits 23
in timber purchases 94
Equalizing the tax burden 263
Equitable standards of valuing damages 161
Estate, a forest 1
Evaluation of insurance losses 300
Even-aged stand of timber, capital value 122
Exemption of immature timber in taxation 281
Expectation value 28
Expense 19

Factors affecting the interest rate 82
determining the entrepreneur's gain 82
determining rate of profit 50
influencing stumpage values 203
of change in value of forest property 48
Figure I Relation of forest finance to other branches of forestry 15
II The business enterprise 18
III Interrelations of marginal costs, marginal utility and market prices in regulating production and consumption 30
IV Relation of cost value, use value and sale value 32
V Determination of true versus speculative market values 85
VI Relation of income to capital value for an even-aged stand or crop of timber 61
VII Rates at which a dollar increases at different rates of compound interest 88
VIII Method of discounting net income from a timber crop as a rental to determine its value for any year *a* 123

PAGE

Figure IX Rate earned by white pine plantation on 50 year rotation based on different costs of soil and given income..... 149
X Indicator graph for white pine plantation in New England.. 151
XI Result of using rate earned x compared with basic rate p in appraising damage to young timber..... 153
XII Effect of increase in value of land on appraised value of young timber..... 169
XIII Derivation of net stumpage value of damaged timber when logging is postponed..... 177
XIV Valuation of damage to property by destruction of a stand of young timber, showing relative values of timber and soil 183
XV Relation of average stumpage prices for a region to increase of stumpage prices on a given tract within this region.... 204

Finance 12
forest, definition and scope..... 12
Financial per cent earned..... 45
Finland fire insurance rates..... 306
Fire hazards..... 289
Fire insurance. *See Insurance.*
Fire insurance, forest..... 295
Fixed investments..... 17
Flow of capital through the business, the..... 20
Forest destruction, economic consequences..... 6
process of..... 3
economics 14
enterprises, rates earned as a basis of investment..... 85
estate, a..... 1
finance, definition and scope..... 12
relation to other branches of forestry..... 14
fire insurance..... 295
improvements 1
insurance organization..... 295
investments, entrepreneur's gain..... 155
hazards in..... 286
rate earned by..... 140
land, marginal value..... 33
taxation, public considerations..... 273
management 16
mensuration 15
Owners' Mutual Insurance Society of France..... 305
producing annual income, capital value of..... 113
policy 15
production, time element in investments in..... 43
property, appraisal of damages..... 175
basis of value for..... 1
capital value of..... 111
cost values of..... 95

PAGE
Forest property, factors of change in value ... 48
historical development of ... 3
market values of ... 130
taxation ... 262
rent ... 76
versus soil rent ... 71
resources ... 5
statics ... 14
taxes, objectives of reform in ... 265
valuation ... 14
whose income is not continuous, capital value of ... 116
Forestry as an organized public enterprise, place of ... 11
Forests as taxable wealth ... 262
Forestry a modern need ... 5
basic rate of interest in ... 92
by public and by private initiative, possibilities of ... 8
creating a going concern in ... 73
definition ... 73
economic basis for ... 1
entrepreneur's gain in ... 84
importance of obtaining gradual transition to ... 10
Forces which determine value ... 34
Formative period in business ... 72
Formulae—annual and intermittent rentals payable forever. V VI VII VIII ... 57, 68, 69
capital value of a forest producing annual income ... 114
whose income is not continuous ... 116
single stands of timber ... 118
an even-aged stand of timber ... 124
bare soil ... 127
compound interest ... 40
cost value for a forest, which is a going concern ... 104
with deferred income ... 106
of a timber crop ... 108
of single stands ... 107
current income per cent ... 45
future value of sum of rentals I ... 66
of intermittent rentals II ... 66
general, for obtaining sum of rentals ... 64
present value of sum of future or discounted rentals III, IV 66
Pressler's ... 54
rate earned, annual, simple interest ... 52
compound interest ... 53
determination ... 42
Pressler's method ... 54
simple interest ... 39
specific, for sum of rentals ... 60

PAGE
Foundation subjects in forest finance 14
France, Forest Owners' Mutual Insurance Society 305
French fire insurance company rates 306
Fumes, injurious 293
Future versus past in summation of rentals 62

General concessions in forest taxation 281
formulæ for obtaining sum of rentals 64
versus local tax reform 267
Gladbacher Fire Insurance Company of Munich, Bavaria, rates 306
Going concern, the 71
cost value of a forest which is 104
creating, in forestry 73
Growth, physical 48
Guarantee of interest on borrowed capital 211

Hazard, biotic 291
climatic 290
conflagration 292
edaphic 290
fungus diseases 293
insects 292
soil 290
total, in insurance 289
wind 292
Hazards, cultural 291
definition and classification 286
exposure 291
fire 289
in forest investments 286
moral 286
negative 286
protection 291
physical 286
reduction and control 287
topographic 291
Historical development of forest property 3
Habit as a deterrent of private forestry 9

Immature timber appraisal, damages 171
damage, partial 189
exemption from taxation 281
taxation 271
total destruction damage 180
Importance of annual income and sustained yield 44
natural resources in modern industry 4

PAGE
Improvements, forest ... 1
market value of ... 138
Income ... 18
and outlay ... 17
business unit the basis of ... 73
continuity of ... 72
earned versus income withdrawn ... 51
from forest taxation ... 278
investments and costs in stumpage appraisals ... 213
net operating ... 74
operating ... 103
taxes versus property taxes ... 263
versus accumulating costs ... 75
Increase in margins for stumpage ... 49
Increment, quality ... 49
Indicator graph for rate earned ... 150
Inducements to private owners in taxation ... 276
Industrialism, the foundations of ... 4
Influence of time on values ... 36
Initial capital investments for timber production ... 98
Insect hazard ... 292
Insurance, adjustment of loss ... 303
characteristics of ... 295
costs ... 305
determination of physical loss ... 304
forest fire ... 295
losses, evaluation ... 300
mutual ... 296
need for statistics ... 297
rates and rating ... 298
rates, Bavaria ... 306
Gladbacher Company, Bavaria ... 306
Norway ... 306
Sweden ... 306
Interest, basic rate in forestry ... 92
compound ... 39
definition ... 23, 36
rate as a commodity price for capital ... 80
as a regulator of enterprise ... 81
of, and entrepreneur's gain ... 80
rates on loans in forest enterprises ... 85
simple ... 38
the true nature of ... 25
Intermittent rentals, conversion into annual ... 70
Intrinsic values ... 35
Investment basis for computing profits ... 47
in timber lands ... 96
method of stumpage appraisals ... 250

PAGE

Investments, fixed 17
forest, entrepreneur's gain in 155
hazards in 286
rate earned by 140
in forest production, time element in 43
in stumpage appraisals 203

Land, basis for values in 46
changes in value of 48
capital value of 126
in production 83
damage to 185
enterprises, determination of profits in 46
forest, marginal value of 33
market value of 134
relation of buyer and seller of 46
taxation, public considerations 273
Law of diminishing returns versus compound interest 87
rent or marginal values 32
Laws, forest taxation, special 282
Liability in insurance 289
License tax on stumpage 282
Liquidation of capital assets 74
Loans in forest enterprises, interest rates on 85
Logging industry 3
Loss, adjustment, in insurance 303
in value, appraised damages 172
Losses 19
and profits 23
insurance, evaluation of 300
Louisiana tax law 282

Management, forest 16
Many-aged stands, damage to 190
Margin for profit and risk in stumpage appraisals 246
Marginal cost 29
utility 29
values, law of rent, or 32
Market value 27
basis of damages 165
of forest property 139
improvements 138
land 134
merchantable timber 135
young timber 137
relation to use and cost values 31
the basis of insurance 302

PAGE
Market values, appraisal of ... 132
basis of ... 131
of forest property ... 130
Mature timber, taxation of ... 268
Measurement of time values in forestry ... 36
Mensuration, forest ... 15
Merchantable timber, appraisal in damages ... 170
damages ... 175
market value of ... 135
Method of charting the per cent curve ... 148
settlement for damages ... 161
trial and error for rate earned ... 144
Michigan, forest taxation ... 282
Minerals ... 5
Mixed stands, stumpage appraisals ... 253
values in ... 255
Monetary changes, effect of ... 49
Money standard of value ... 34
Monopoly strength ... 30
values ... 29
Moral hazard ... 292
hazards ... 286
Mutual insurance ... 296
Company, Sampo, Finland ... 306
Society, Forest Owners', France ... 305

Natural forces in forest production ... 44
Natural resources, importance of, in modern industry ... 4
Need for public ownership ... 11
Negative hazards ... 286
Net operating income versus liquidation of capital assets ... 74
Norway, fire insurance ... 306
Nuisance value ... 139

Objectives of reform in forest taxation ... 265
Operating costs, annual expenses ... 101
in forestry ... 98
income ... 103
business unit the basis of ... 73
net ... 74
versus accumulating costs ... 75
value of stumpage ... 136
Organization, forest insurance ... 295
Other market values ... 138
Outlay and income ... 17
Overcutting ... 52
Overturn methods in stumpage appraisals ... 247

PAGE
Partial damage to immature timber ... 189
Past versus future in summation of rentals ... 62
Pennsylvania, forest taxation ... 282
Phenomena of price ... 31
Physical basis of appraisals of damages ... 167
stumpage values ... 198
hazards ... 286
loss, determination in insurance ... 304
Place of forestry as an organized public enterprise ... 11
Policy, forest ... 15
Positive versus relative values ... 27
Possession and use, the basis of damages ... 161
Possible concessions or inducements to private owners, in taxation ... 276
Possibilities of forestry by public and by private initiative ... 8
Potential forest property ... 1
Present moment as the basis of valuation ... 41
Pressler's formula ... 54
Price for capital, interest rate as ... 80
increase in unit ... 49
increment, general ... 49
Prices of interest ... 82
Principle of damages ... 160
Principles, economic, underlying forest finance ... 27
underlying the appraisal of damages ... 160
Private forestry, profit in relation to ... 7
initiative in forestry ... 9
owners, concessions in taxation ... 276
ownership, destructive tendencies of ... 9
versus public ownership ... 7
Present tax conditions on timberlands ... 265
Problem of equalizing the tax burden ... 263
Process of forest destruction, the ... 3
Products of forest land ... 1
special, stumpage value of ... 257
Profit, definition ... 12
annual, rate, direct appraisal ... 56
in a going concern ... 104
relation to public and to private forestry ... 7
rate of, factors determining the ... 50
versus ratio of ... 55
ratio of versus rate of compound interest ... 89
the two sources of ... 47
Profits and losses ... 23
average and deferred ... 51
comparison on basis of annual rate earned ... 52
definition ... 24
in land enterprises ... 46
terms of capital values ... 56

PAGE
Profits, investment basis for computing 47
of the undertaking 23
proprietor's, and borrowed capital 22
versus entrepreneur's gain 23
Property, forest 1
tax, failure of, as inducement to practice forest production .. 279
on immature timber 271
versus tax at time of cutting 269
taxes 262
computation 283
Proprietor's capital 21
Protection costs 101
as damage 187
hazard 291
Protective values 2
Public considerations in taxation of forest land 273
coöperation in forestry 9
enterprise, place of forestry as an organized 11
forestry, profit in relation to 7
initiative in forestry 8
ownership, need for 11
private versus 7
Punitive damages 196
Purchase areas 130
of stumpage, appraisals for 260

Quality increment 49

Rate earned 23
annual 52
annually 140
as basis of appraisals of young timber 150
by a timber crop 143
forest investments 140
determination of the 42
effect on value 71
indicator graph 150
method of trial and error 144
the per cent curve 148
of annual profit, direct appraisal 56
compound interest versus ratio of profit 89
income earned 13
Rate of interest. *See interest rate.*
Rate of interest, and entrepreneur's gain 80
as regulator of enterprise 81
basic, in forestry 92
versus compound interest 89

PAGE

Rate of profit, factors determining 50
versus ratio of profit 55
Rates and rating, insurance 298
earned as a basis of investment in forest enterprises 85
over a period of deferred returns 140
forest fire insurance, Bavaria 306
Finland 306
France 305
Norway 306
Sweden 306
of current or annual income 44
Ratio of profit versus rate of compound interest 89
versus rate of profit 55
Raw material, wood as a 6
materials, marginal value of 33
a source of 5
Readjustment of stumpage values in long term sales 207
Reasons for failure of property tax as inducement to practice forest production 279
Recreational values 2, 138
damage to 195
Reduction or control of hazards 287
Reëstablishing new crop, as damage 186
Reform in forest taxation, objectives 265
Reinvestment, principle of 40
Relation of forest finance to other branches of forestry 14
proprietor's profits and borrowed capital 22
use, cost and market values 31
Relative versus positive values 27
Rentals 60
conversion of intermittent into annual 70
formulae for sum of, general 64
specific 66
past versus future 62
summation of 60
Rent, forest 76
versus soil 71
or marginal values, law of 32
soil 77
Reorganization of a business 48
Reserve of industry 86
Returns to capital 21
Risk, element of 82
to capital 21
Royalty value of stumpage 136

Sampo Mutual Insurance Company, Finland 306
Sale value 32

PAGE
Sales, long term, readjustment of stumpage values in ... 207
small, stumpage values in ... 257
Scope of Forest Finance ... 12
Seed trees ... 100
Separation of timber and soil values in damages ... 181
Settlement of damages, method of ... 161
Severance tax on stumpage ... 270
Silvics ... 14
Silviculture ... 15
Simple interest and discount ... 38
Single stands, cost value of ... 107
of timber with deferred income, capital value of ... 118
Slash disposal ... 100
Soil, capital value of ... 126
damage as damage to succeeding crop ... 188
rent ... 77
versus forest rent ... 71
value, appraisal ... 167
Source of value ... 34
Sources of profit, the two ... 47
raw materials ... 5
value ... 2
Special concessions in forest taxation ... 282
Specific formulae for sum of rentals ... 60
Speculative timber holdings, cost value of ... 107
turnovers ... 58
values ... 35
Standard of value ... 34
Standards of valuing damages, equitable ... 161
Stands, many-aged, damage to ... 190
single, cost value of ... 107
State insurance ... 297
Static exchanges ... 20
Statics, Forest ... 14
Statistics, need in insurance ... 297
Stock companies, insurance ... 296
Submarginal land ... 33
Stumpage appraisals, analysis of a proposed operation ... 218
annual depreciation, calculation ... 230
application of investment method in mixed stands 253
appraisals for purchase of stumpage ... 260
average profit-bearing investment, calculation ... 230
basis for computing the margin for profit and risk 246
calculation of annual depreciation and average profit-bearing investment ... 230
classification of operating costs ... 233
cost, elements of ... 216

PAGE

Stumpage appraisals, depreciation. annual, calculation 230
definition 217
of fixed investments 225
physical basis for 229
elements of cost 216
equipment, investment in 220
fixed investments, definition 216
investments 222
depreciation of 225
form for summarizing essential data 258
general expense, definition 218
gross income 214
income, investments and costs 213
inferior species, distribution of loss on 256
initial fixed investment, definition 217
interest, definition 218
investment, average profit-bearing, calculation 230
in logging improvements 220
logging 222
manufacturing 223
method 250
application to mixed stands .. 253
layout of operation 219
logging improvements 220
investment 222
loss on inferior species, the distribution of 256
lumber selling prices 221
maintenance, definition 217
manufacturing investment 223
plant investment 220
margin for profit and risk 243
basis for 246
definition 218
minimum stumpage values 256
operating costs, classification 233
definition 217
determination 221
overhead charges, definition 218
overrun 221
effect on value 241
overturn method 247
modifications of 249
physical depreciation 229
profit, definition 218
margin for 243
basis for computing 246
profit-bearing investment, calculation 230
residual and wrecking values, definition 217

PAGE

Stumpage appraisals, risk, margin for ... 243
risks ... 244
small sales ... 257
special products ... 257
standard classification of operating costs ... 233
stumpage values in mixed stands ... 255
working capital, determination ... 221, 238
wrecking value, definition ... 217
Stumpage, cost versus value of ... 209
purchase of, appraisals for ... 260
royalty value ... 136
value, basis of appraisal ... 206
by overturn methods ... 247
investment method ... 250
values ... 231
basis of ... 197
changes in ... 203
definition ... 197
economic basis of ... 200
in mixed stands ... 255
physical basis of ... 198
readjustment in long-term sales ... 207
six factors influencing ... 203
Substitutes for wood ... 6
Sum of rentals, formulae ... 64
Summation of rentals ... 60
Sustained yield, importance of ... 44
Swedish Veritas Stock Company, insurance ... 306

Table I Comparison of profits and compound interest on an investment of $1.00 ... 90
II Equivalents of 1 per cent compound interest at different rates 92
III Basis for physical depreciation ... 229
IV Total cash taxes on 1 acre for 50 years ... 275
V Total taxes and interest on 1 acre for 50 years ... 276
VI Comparison of property taxes on pine timber under partial and no exemption ... 277
VII Comparison of property taxes on hardwood timber under partial and no exemption ... 278
VIII Forest insurance schedule of rates for the state of Michigan. Commercial companies ... 299
IX Rates quoted by Forest Owners' Mutual Insurance Society of France ... 305
X Rates quoted by General Syndicate of French Fixed Premium Fire Insurance Companies ... 306
XI Rates quoted by Gladbacher Fire Insurance Company of Munich, Bavaria ... 306
XII Rates quoted by the Swedish Veritas Stock Company ... 306

PAGE
Tax at time of cutting ... 269
burden, equalizing the ... 263
conditions on timber lands ... 265
income produced by forests under different systems of taxation ... 274
reform, general versus local ... 267
Taxable wealth, forests as ... 262
Taxation as a deterrent of private forestry ... 9
of forest land bearing immature timber ... 271
public considerations ... 273
property ... 262
mature timber ... 268
Taxes, income versus property ... 262
property ... 262
computation ... 282
Timber and soil, separation of value in damages ... 181
capital value of, even-aged stands ... 122
single stands ... 118
crop, rate earned by ... 143
cost of producing ... 108
holdings, speculative, cost value of ... 107
immature, appraisal of damages ... 171
partial damage ... 189
taxation of ... 271
total destruction, damage ... 180
lands, capital investment in ... 96
tax conditions on ... 265
mature, taxation of ... 268
merchantable, appraisal, in damages ... 170
damage, formula ... 175
market value of ... 135
rights ... 260
stumpage, marginal value of ... 33
which cannot be logged immediately, damage ... 176
young, market value of ... 137
rate earned as basis of appraisals ... 150
Time element in investments in forest production ... 43
influence on values ... 36
the great obstacle ... 5
values in forestry ... 36
Total destruction of immature timber, damage ... 180
hazard ... 289
Transition from savagery, the ... 3
to forestry, importance of gradual ... 10
Trespass ... 293
True cost ... 25
nature of investment ... 25
Two sources of profit, the ... 47

PAGE

Underwriters 296
Unearned increment 36
Universal principle of damages 160
Use as a basis of damages 161
cost and market values, relation of 31
value 28, 111
versus cost value 28
Utility, marginal 29
Utilized energy, dependency of value on 36

Valuation, basis of, the present moment 41
Valuation, forest 14
Value, capital 28
of forest property 111
capitalized income 28
rental 28
dependence on utilized energy 36
effect of rate earned on 71
expectation 28
for forest property, basis of 1
forces which determine 34
intrinsic 35
loss in, appraisal, damages 172
market 27
of margins 86
property 13
soil, appraisal 167
capital 126
sources of 2
stumpage overturn method 247
versus cost of stumpage 209
Values in land, basis for 46
market 130
marginal, the law of rent 32
monopoly 29
of capital invested in land, changes in 48
positive versus relative 27
recreational, damage to 195
speculative 35
stumpage, basis of 197
Valuing damages, equitable standards of 161
Virgin timber as a deterrent of private forestry 9

Watersheds, damage to 194
values 139
Withdrawn income versus earned 51
Wind hazard 292

PAGE
Wood as a raw material 6
substitute 6
Working capital 19

Yield tax, substitution of, for tax on immature timber 281
versus property tax 269
Young timber, market value of 137
rate earned as basis of appraisals of 150

4.15

$L_c = .01745\ RI$